## Operation Manual

3B Series – Rev 1.6.1 P/N 160925-10

# 3B Series
# Programmable AC & DC load


**ADAPTIVE** Power Systems

Worldwide Supplier of Power Equipment

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# Table of Contents

# Table of Tables

# Table of Figures

# 1 Contact Information

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# 2 Front Matter

## 2.1 Limited Warranty

Adaptive Power Systems, Inc. (APS) warrants each unit to be free from defects in material and workmanship. For the period of one (1) year from the date of shipment to the purchaser, APS will either repair or replace, at its sole discretion, any unit returned to the APS factory in Irvine, California or one of its designated service facilities. It does not cover damage arising from misuse of the unit or attempted field modifications or repairs. This warranty specifically excludes damage to other equipment connected to this unit.

Upon notice from the purchaser within (30) days of shipment of units found to be defective in material or workmanship, APS will pay all shipping charges for the repair or replacement. If notice is received more than thirty (30) days from shipment, all shipping charges shall be paid by the purchaser. Units returned on debit memos will not be accepted and will be returned without repair.

**This warranty is exclusive of all other warranties, expressed or implied.**

## 2.2 Service and Spare Parts Limited Warranty

APS warrants repair work to be free from defects in material and workmanship for the period of ninety (90) days from the invoice date. This Service and Spare Parts Limited Warranty applies to replacement parts or to subassemblies only. All shipping and packaging charges are the sole responsibility of the buyer. APS will not accept debit memos for returned power sources or for subassemblies. Debit memos will cause return of power sources or assemblies without repair.

**This warranty is exclusive of all other warranties, expressed or implied.**

## 2.3 Safety Information

This chapter contains important information you should read BEFORE attempting to install and power-up APS Equipment. The information in this chapter is provided for use by experienced operators. Experienced operators understand the necessity of becoming familiar with, and then observing, life-critical safety and installation issues. Topics in this chapter include:

- Safety Notices
- Warnings
- Cautions
- Preparation for Installation
- Installation Instructions

Make sure to familiarize yourself with the **SAFETY SYMBOLS** shown on the next page. These symbols are used throughout this manual and relate to important safety information and issues affecting the end user or operator.

## SAFETY SYMBOLS

**Direct current (DC)**

**Alternating current (AC)**

**Both direct and alternating current**

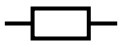

**Three-phase alternating current**

**Protective Earth (ground) terminal**



**On (Supply)**

**Off (Supply)**



**Fuse**

**Caution: Refer to this manual before this Product.**

**Caution, risk of electric shock**

## 2.4 Safety Notices

**SAFETY SUMMARY**

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Adaptive Power Systems assumes no liability for the customer's failure to comply with these requirements.

**GENERAL**

This product is a Safety Class 1 instrument (provided with a protective earth terminal). The protective features of this product may be impaired if it is used in a manner not specified in the operation instructions.

**ENVIRONMENTAL CONDITIONS**

This instrument is intended for indoor use in an installation category I, pollution degree 2 environments. It is designed to operate at a maximum relative humidity of 80% and at altitudes of up to 2000 meters. Refer to the specifications tables for the ac mains voltage requirements and ambient operating temperature range.

**BEFORE APPLYING POWER**

Verify that the product is set to match the available line voltage and the correct fuse is installed.

**GROUND THE INSTRUMENT**

This product is a Safety Class 1 instrument (provided with a protective earth terminal). To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument must be connected to the AC power supply mains through a properly rated three-conductor power cable, with the third wire firmly connected to an electrical ground (safety ground) at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

**FUSES**

Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired Fuses or short circuit the fuse holder. To do so could cause a shock or fire hazard.

**DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE.**

Do not operate the instrument in the presence of flammable gases or fumes.

**KEEP AWAY FROM LIVE CIRCUITS.**

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified service personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power, discharge circuits and remove external voltage sources before touching components.

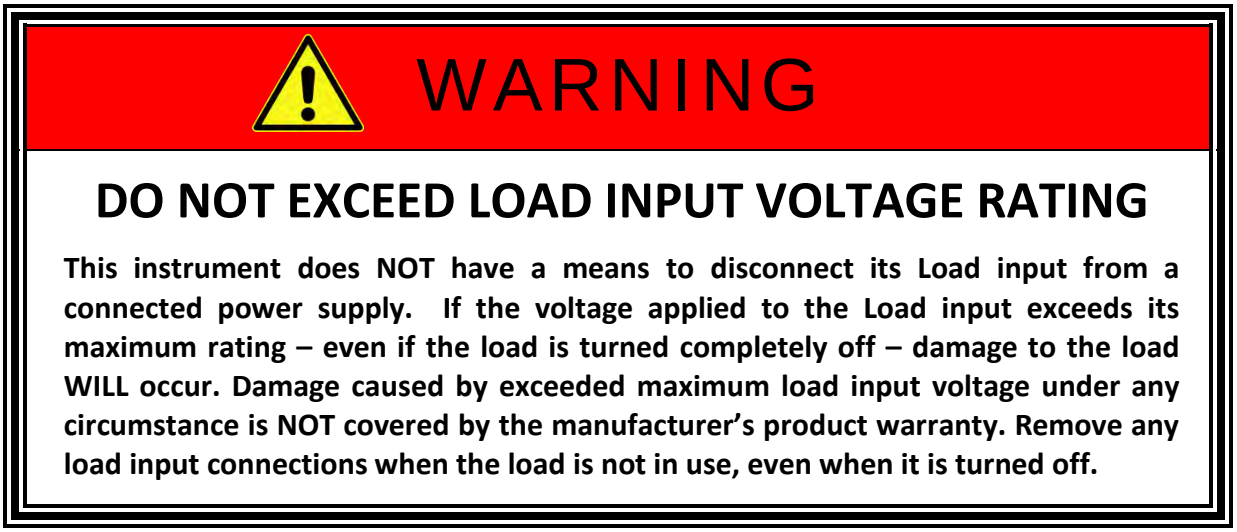
**DO NOT SERVICE OR ADJUST ALONE.**

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

**DO NOT EXCEED INPUT RATINGS.**

This instrument may be equipped with a line filter to reduce electromagnetic interference and must be connected to a properly grounded receptacle to minimize electric shock hazard. Operation at line voltages or frequencies in excess of those stated on the data plate may cause leakage currents in excess of 5.0 mA peak.

**DO NOT EXCEED LOAD INPUT VOLTAGE RATING.**




**DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT.**

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to an Adaptive Power Systems Sales and Service Office for service and repair to ensure that safety features are maintained.

Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

# 3 Product Overview

This chapter provides an overview of the APS 3B Series programmable AC & DC loads. It introduces the reader to general operating characteristics of these loads.

## 3.1 General Description

The APS 3B Series electronic load is designed to test, evaluation and burn-in of AC or DC power supplies and batteries. The APS 3B Series electronic load can be operated from the front panel (manual mode) or using RS232 or GPIB remote control.

The VI curve constant power contours of the various 3B Series models are shown in the Technical Specification Section. Maximum current and power capability depends on the specific model.

## 3.2 Operating Modes

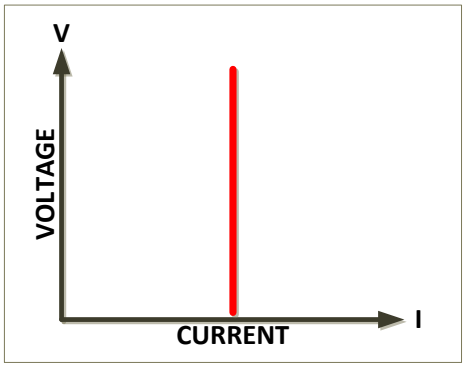
Available operating modes for all models are:

- Constant Current (CC) mode
- Linear Constant Current (LIN) mode
- Constant Resistance (CR) mode

A more detailed explanation of each mode and under what condition each mode is most appropriate to use follows.

### 3.2.1 Constant Current Mode

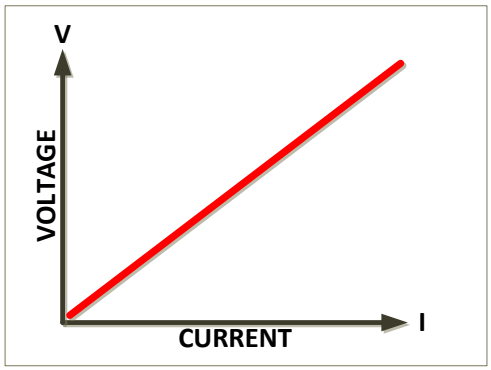
This is the most commonly used mode of operating when testing a voltage source such as an AC power source, DC supply or battery. In this mode of operation, the load will sink a constant level of current as set by the user, regardless of any voltage variations. A real time feedback loop ensures a stable current under any voltage variation of the AC source, DC supply or battery.




This mode is recommended for load regulation testing, loop stability testing, battery discharge testing and any other form of voltage regulation loop testing.

### 3.2.2 Linear Constant Current Mode (LIN)

When operating in linear constant current mode, the load current input into the 3B Series load depends on the current setting regardless of the input voltage, e.g., the current rms level remains unchanged. The load current will follow the input voltage waveform in real-time.




The LIN mode is implemented through a high-bandwidth auto gain control circuit (ACG) and the ACG output current control signal will track the input voltage. The AGC circuit produces a constant amplitude output signal so long as the amplitude of the input signal exceeds an adjustable reference voltage applied to the peak detector. The reference voltage may be changed to change the range of input voltage resulting in a constant-amplitude output.

The AGC circuit responds almost instantly to adjust for a sudden increase in input voltage. This fast voltage transient response makes the LIN mode especially suitable for non-sinusoidal AC voltage inputs such as step waveform, square waveform and any AC input voltage with a highly distorted waveform.

### 3.2.3 Constant Resistance Mode (CR)

In Constant Resistance mode, the load will sink current directly proportional to the sensed input voltage. The ratio between voltage and current is linear per ohms law and can be set by the user within the operating range of the AC & DC load. The current is defined by the formula shown here where R is the set value in CR mode and V is the AC or DC input voltage from the unit under test.

$$I = V/R$$

CR mode is useful for battery discharge testing of battery systems used to power constant impedance loads as the voltage will decrease as the battery discharges over time resulting in reduced current sinking.

## 3.3 Current Read-back

The current levels and load status for each load can be set from the front panel or over the remote control interface. During testing, load input voltage and load current can be read back but the current read back will typically display the average current level unless the dynamic current frequency setting is low enough. An analog current monitor output is provided to allow capturing of dynamic current on a digital storage scope or data recorder.

## 3.4 External Sync Mode

An external Sync input BNC connector is provided at the rear panel of the load chassis. This input allows for synchronization of the AC current with an external reference. Without an external sync signal, the AC source will sink to the sensed AC voltage using its internal zero crossing detection circuit.

**Note:** This mode is supported in Constant Current (CC) and Linear Current (LIN) modes only.

## 3.5 Product Features

The following key characteristics apply to all 3B Series models.

- Fully programmable electronic AC & DC load with flexible configuration and dual range capabilities.
- Fully remote control of all load settings and metering read back.
- Dual high accuracy and high-resolution voltage and current meters.
- DC or 0.1 to 400 Hz frequency range support (CC and LIN modes).
- Power factor (PF) and crest factor (CF) control (CC and LIN modes).
- Load ON/OFF switch change and power supply turn ON.
- Internal or external voltage sensing.
- Automatic Go/NoGo testing.
- Full protection from over power, over temperature, over voltage, and reverse polarity.
- Analog current monitor output (I-Monitor).
- External sync input.
- Variable speed fan control for quiet operation.

## 3.6 Accessories Included

The following accessories are included with each 3B Series AC & DC load. If one or more of these is missing upon incoming inspection of the product, please contact Adaptive Power Systems customer service.

| Item | Quantity |
|---|---|
| Operation Manual in hardcopy or PDF Format on CD ROM | 1 |
| AC Line Cord | 1 |
| Banana Terminal, Red | 1 |
| Banana Terminal, Black | 1 |
| Spade Lug, Large | 2 |
| Voltage Sense alligator clip lead cable, Red/Black (1 meter, 39.4”) | 1 |
| BNC Cable (1 meter, 3 feet) for I-Monitor and Ext. Sync. | 2 |
| Certificate of Conformance | 1 |

*Table 3-1: Included Accessories*

# 4 Technical Specifications

Technical specifications shown here apply at an ambient temperature of 25° C ± 5°. Refer to V-I curve and Very Low Voltage V-I Curve charts by models for operating envelope.

## 4.1 Operating Ranges

| MODEL | 3B012-12 | | 3B018-18 | | 3B024-24 | | 3B036-36 | | 3B054-54 | |
|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING RANGES | | | | | | | | | | |
| Power Ranges | 0 - 1200 VA | | 0 - 1800 VA | | 0 - 2400 VA | | 0 - 3600 VA | | 0 - 5400 VA | |
| Current Ranges | 0 -6 A | 6 -12 A | 0 - 9 A | 9 - 18 A | 0 - 12 A | 12-24 A | 0-18 A | 18-36 A | 0-27 A | 27-54 A |
| Voltage Range | 50 - 300 Vrms | | 50 - 300 Vrms | | 50 - 300 Vrms | | 50 - 300 Vrms | | 50 - 300 Vrms | |
| Min. Input Voltage | 1.0 Vrms | | | | | | | | | |
| Frequency | DC, 40 - 400Hz (CC Mode) / DC - 400Hz (LIN,CR Mode) | | | | | | | | | |
| AC Waveforms | Sine, Square, Step, DC | | | | | | | | | |

| MODEL | 3B072-72 | | 3B090-90 | | 3B108-108 | | 3B126-126 | |
|---|---|---|---|---|---|---|---|---|
| OPERATING RANGES | | | | | | | | |
| Power Ranges | 0 - 7200 VA | | 0 - 9000 VA | | 0 - 10800 VA | | 0 - 12600 VA | |
| Current Ranges | 0 -36 A | 36 - 72 A | 0 - 45 A | 45 - 90 A | 0 - 54 A | 54 - 108 A | 0 - 63 A | 63 - 126 A |
| Voltage Range | 50 - 300 Vrms | | 50 - 300 Vrms | | 50 - 300 Vrms | | 50 - 300 Vrms | |
| Min. Input Voltage | 1.0 Vrms | | | | | | | |
| Frequency | DC, 40 - 400Hz (CC Mode) / DC - 400Hz (LIN,CR Mode) | | | | | | | |
| AC Waveforms | Sine, Square, Step, DC | | | | | | | |

## 4.2 Operating Modes

| MODEL | 3B012-12 | | 3B018-18 | | 3B024-24 | | 3B036-36 | | 3B054-54 | |
|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING MODES | | | | | | | | | | |
| CC Mode - High Range | 0 -6 A | 6 -12 A | 0 - 9 A | 9 - 18 A | 0 - 12 A | 12-24A | 0-18A | 18-36A | 0-27A | 27-54A |
| Resolution | 1.5 mA | 3.0 mA | 2.25 mA | 4.5 mA | 3.0 mA | 6.0 mA | 4.5 mA | 9.0 mA | 6.75 mA | 13.5 mA |
| Accuracy | 50Hz & 60Hz: ± 0.5% OF (SETTING + RANGE) / > 60 Hz: ±(0.5% OF SETTING + 1% OF RANGE) | | | | | | | | | |
| CC Mode - Low Range | 0 - 0.6 A | | 0 - 0.9 A | | 0 - 1.2 A | | 0 - 1.8 A | | 0 - 2.7 A | |
| Accuracy | ±2% OF (SETTING + RANGE) | | | | | | | | | |
| CC Linear Mode . | Refer to CC Mode data | | | | | | | | | |
| Crest Factor Mode Range | √2 - 3.5 / 1.5 - 1.9 / 3.0 - 3.4 | | | | | | | | | |
| Resolution | 0.5 / 0.1 / 0.1 | | | | | | | | | |
| Lagging | -0.30 to -0.85 for CF 2.0 to 3.5 | | | | | | | | | |
| Leading | +0.30 to +0.85 for CF 2.0 to 3.5 | | | | | | | | | |
| CR Mode Range | 5 - 20Ω | 20 - 80kΩ | 3.333-13.33Ω | 13.33-3.332kΩ | 2.5 - 10Ω | 10-40kΩ | 1.667-6.668Ω | 6.668-26.668kΩ | 1.111 - 4.444Ω | 4.444-17.776kΩ |
| Resolution(1) | 0.052 mS | 0.013 mS | 0.076 mS | 0.019 mS | 0.1 mS | 0.025 mS | 0.148 mS | 0.037 mS | 0.224 mS | 0.056 mS |
| Accuracy | 50Hz & 60Hz: ± 0.5% OF (SETTING + RANGE) / > 60 Hz: ±(0.5% OF SETTING + 2% OF RANGE) | | | | | | | | | |

| MODEL | 3B072-72 | | 3B090-90 | | 3B108-108 | | 3B126-126 | |
|---|---|---|---|---|---|---|---|---|
| OPERATING MODES | | | | | | | | |
| CC Mode - High Range | 0 -36 A | 6 -72 A | 0 – 45 A | 9 – 90 A | 0 - 54 A | 12 - 108 A | 0-63 A | 63 - 126 A |
| Resolution | 9 mA | 18 mA | 11.25 mA | 21.5 mA | 13.5 mA | 27 mA | 15.75 mA | 31.5 mA |
| Accuracy | 50Hz & 60Hz: ± 0.5% OF (SETTING + RANGE) / > 60 Hz: ±(0.5% OF SETTING + 1% OF RANGE) | | | | | | | |
| CC Mode - Low Range | 0 - 3.6 A | | 0 - 4.5 A | | 0 - 5.4 A | | 0 - 6.3 A | |
| Accuracy | ±2% OF (SETTING + RANGE) | | | | | | | |
| CC Linear Mode . | Refer to CC Mode data | | | | | | | |
| Crest Factor Mode Range | √2 - 3.5 / 1.5 - 1.9 / 3.0 - 3.4 | | | | | | | |
| Resolution | 0.5 / 0.1 / 0.1 | | | | | | | |
| Lagging | -0.30 to -0.85 for CF 2.0 to 3.5 | | | | | | | |
| Leading | +0.30 to +0.85 for CF 2.0 to 3.5 | | | | | | | |
| CR Mode Range | 0.833-3.333Ω | 3.333-13.33kΩ | 0.666-2.666Ω | 2.666-10.666kΩ | 0.556-2.224Ω | 2.224-8.888kΩ | 0.476-1.904Ω | 1.904-7.616kΩ |
| Resolution(1) | 0.300 mS | 0.075 mS | 0.375 mS | 0.094 mS | 0.452 mS | 0.113 mS | 0.525 mS | 0.131 mS |
| Accuracy | 50Hz & 60Hz: ± 0.5% OF (SETTING + RANGE) / > 60 Hz: ±(0.5% OF SETTING + 2% OF RANGE) | | | | | | | |

## 4.3 Protection Modes

| MODEL | 3B012-12 | 3B018-18 | 3B024-24 | 3B036-36 | 3B054-54 |
|---|---|---|---|---|---|
| PROTECTION | | | | | |
| Over Power (OP) | 1260 VA | 1890 VA | 2520 VA | 3780 VA | 5570 VA |
| Over Current (OC) | 12.6 A | 18.9 A | 25.2 A | 37.8 A | 25.7 A |
| Over Voltage (OV) | 315 V | | | | |
| Over Temperature (OT) | +85° C / +185° F | | | | |

| MODEL | 3B072-72 | 3B090-90 | 3B108-108 | 3B126-126 |
|---|---|---|---|---|
| PROTECTION | | | | |
| Over Power (OP) | 7560 VA | 9450 VA | 11340 VA | 13230 VA |
| Over Current (OC) | 75.6 A | 94.5 A | 113.4 A | 132.3 A |
| Over Voltage (OV) | 315 V | | | |
| Over Temperature (OT) | +85° C / +185° F | | | |

## 4.4 Power Factor & Crest Factor Range

| MODEL | 3B012-12 | 3B018-18 | 3B024-24 | 3B036-36 | 3B054-54 |
|---|---|---|---|---|---|
| CREST & POWER FACTOR RANGE | | | | | |
| Lagging PF | CF: √2 to 3.5 . PF: - 0.30 to -0.85 | | | | |
| Leading PF | CF: √2 to 3.5 . PF: + 0.30 to +0.85 or 1.00 | | | | |

| MODEL | 3B072-72 | 3B090-90 | 3B108-108 | 3B126-126 |
|---|---|---|---|---|
| CREST & POWER FACTOR RANGE | | | | |
| Lagging PF | CF: √2 to 3.5 . PF: - 0.30 to -0.85 | | | |
| Leading PF | CF: √2 to 3.5 . PF: + 0.30 to +0.85 or 1.00 | | | |

## 4.5 Metering

| MODEL | | 3B012-12 | 3B018-18 | 3B024-24 | 3B036-36 | 3B054-54 |
|---|---|---|---|---|---|---|
| METERING | | | | | | |
| Voltage | Range | 0 - 300 V | | | | |
| | Resolution | 0.1 V | | | | |
| | Accuracy | ±(0.5% OF SETTING + 0.2% OF RANGE) | | | | |
| Current | Range | 0 - 12 A | 0 - 18 A | 0 - 24 A | 0 - 36 A | 0 - 54 A |
| | Resolution | 0.001 A | 0.001 A | 0.01 A | 0.01 A | 0.012 A |
| | Accuracy | 50Hz & 60Hz: ± 0.5% OF (READING + RANGE) / > 60 Hz: ±(0.5% OF READING + 2% OF RANGE) | | | | |
| Power | Range | 0 - 1200 W | 0 - 1800 W | 0 - 2400 W | 0 - 3600 W | 0 - 5400 W |
| | Resolution | 0.1 W | 0.1 W | 0.1 W | 1 W | 1.2 W |
| | Accuracy | 50Hz & 60Hz: ± 0.5% OF (READING + RANGE) / > 60 Hz: ±(0.5% OF READING + 2% OF RANGE) | | | | |
| Apparent Power | Range | 0 - 1200 VA | 0 - 1800 VA | 0 - 2400 VA | 0 - 3600 VA | 0 - 2400 VA |
| | Resolutions | 0.1 VA | 0.1 VA | 0.1 VA | 1 VA | 1.2 VA |
| | Accuracy | Derived from Volt and Current Measurement | | | | |

| MODEL | | 3B012-12 | 3B018-18 | 3B024-24 | 3B036-36 |
|---|---|---|---|---|---|
| METERING | | | | | |
| Voltage | Range | 0 - 300 V | | | |
| | Resolution | 0.1 V | | | |
| | Accuracy | ±(0.5% OF SETTING + 0.2% OF RANGE) | | | |
| Current | Range | 0 - 72 A | 0 - 90 A | 0 - 108 A | 0 - 126 A |
| | Resolution | 0.012 A | 0.012 A | 0.012 A | 0.014 A |
| | Accuracy | 50Hz & 60Hz: ± 0.5% OF (READING + RANGE) / > 60 Hz: ±(0.5% OF READING + 2% OF RANGE) | | | |
| Power | Range | 0 - 7200 W | 0 - 9000 W | 0 - 10800 W | 0 - 12600 W |
| | Resolution | 1.2 W | 1.2 W | 1.2 W | 1.2 W |
| | Accuracy | 50Hz & 60Hz: ± 0.5% OF (READING + RANGE) / > 60 Hz: ±(0.5% OF READING + 2% OF RANGE) | | | |
| Apparent Power | Range | 0 - 7200 VA | 0 – 9000 VA | 0 - 10800 VA | 0 - 12600 VA |
| | Resolutions | 1.2 VA | 1.2 VA | 1.2 VA | 1.2 VA |
| | Accuracy | Derived from Volt and Current Measurement | | | |

## 4.6 Analog I/O

| MODEL | 3B012-12 | 3B018-18 | 3B024-24 | 3B036-36 | 3B054-54 |
|---|---|---|---|---|---|
| ANALOG I/O | | | | | |
| Current Monitor Out | 3 A/V | 4.5 A/V | 6 A/V | 9 A/V | 13.5 A/V |
| Accuracy | ± 0.5% OF (SETTING + RANGE) | | | | |

| MODEL | 3B072-72 | 3B090-90 | 3B108-108 | 3B126-126 |
|---|---|---|---|---|
| ANALOG I/O | | | | |
| Current Monitor Out | 18 A/V | 22.5 A/V | 27 A/V | 31.5 A/V |
| Accuracy | ± 0.5% OF (SETTING + RANGE) | | | |

## 4.7 AC Input & Cooling

| MODEL | All Models |
|---|---|
| AC INPUT AND COOLING | |
| AC Power | 100/115 ±10% or 200/230V ±10%, 50/60 Hz |
| Cooling | Variable speed fan, front air intake, rear exhaust |

## 4.8 Dimensions & Weight

| MODEL | 3B012-12 | 3B018-18 | 3B024-24 | 3B036-36 | 3B054-54 |
|---|---|---|---|---|---|
| DIMENSIONS AND WEIGHT | | | | | |
| Dimensions (W x H x D) | 440 x 177 x 445 mm / 17.3" x 7.0" x 17.5 | | 596 x 889 x 600 mm / 23.5" x 35" x 23.6" | | |
| Post June 2016 Dims | No change | | 600 x 839 x 600 mm / 23.6" x 33" x 23.6" | | |
| Weight (Net) | 18.5 kg / 40.8 lbs | 21.5 kg / 47.4 lbs | 77.0 kg / 169.8 lbs | 77.0 kg / 169.8 lbs | 98.5 kg / 217.2 lbs |

| MODEL | 3B072-72 | 3B090-90 | 3B108-108 | 3B126-126 |
|---|---|---|---|---|
| DIMENSIONS AND WEIGHT | | | | |
| Dimensions (W x H x D) | 596x1556x600 mm / 23.5" x 61.3" x 23.6" | | | 596x1778x600 mm/23.5"x70"x23.6" |
| Post June 2016 Dims | 600x1283x600 mm / 23.6" x 50.5" x 23.6" | | 600x1506x600 mm / 23.6" x 59.3" x 23.6" | 600x1728x600 mm/23.6"x68"x23.6" |
| Weight (Net) | 153 kg / 337.3 lbs | 174.5 kg / 384.7 lbs | 196.0 kg / 432.1 lbs | 230.5 kg / 508.2 lbs |

## 4.9 Environmental

| MODEL | All Models |
|---|---|
| AC INPUT AND COOLING | |
| Operating Temperature | 0 - 40° C / 32 - 104° F |
| Relative Humidity | 80% max. non-condensing |
| Environmental | Indoor Use Only, Pollution Degree 2 |
| Altitude | 2000 meter / 6500 feet max. Operating |
| EMC & Safety | CE Mark |

## 4.10 Voltage versus Current Operating Envelope Charts

Following charts show constant power operating envelopes for each load model. Operation below the low voltage level is not possible as the load will turn off if insufficient input voltage is sensed.

### 4.10.1 Model 3B012-12 V-I Curve

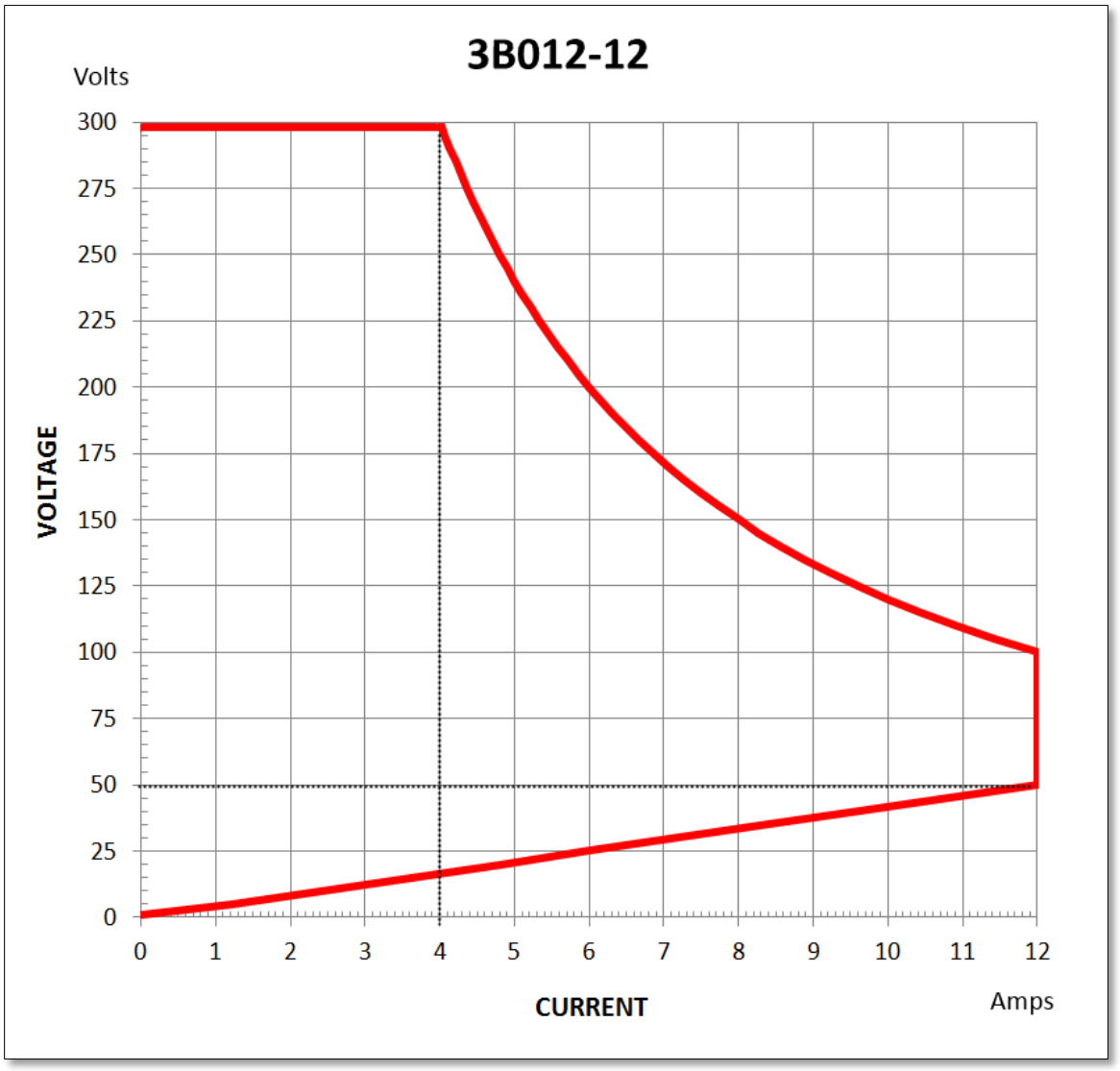



*Figure 4-1: Model 3B012-12 V-I Curve*

### 4.10.2 Model 3B018-18 V-I Curve

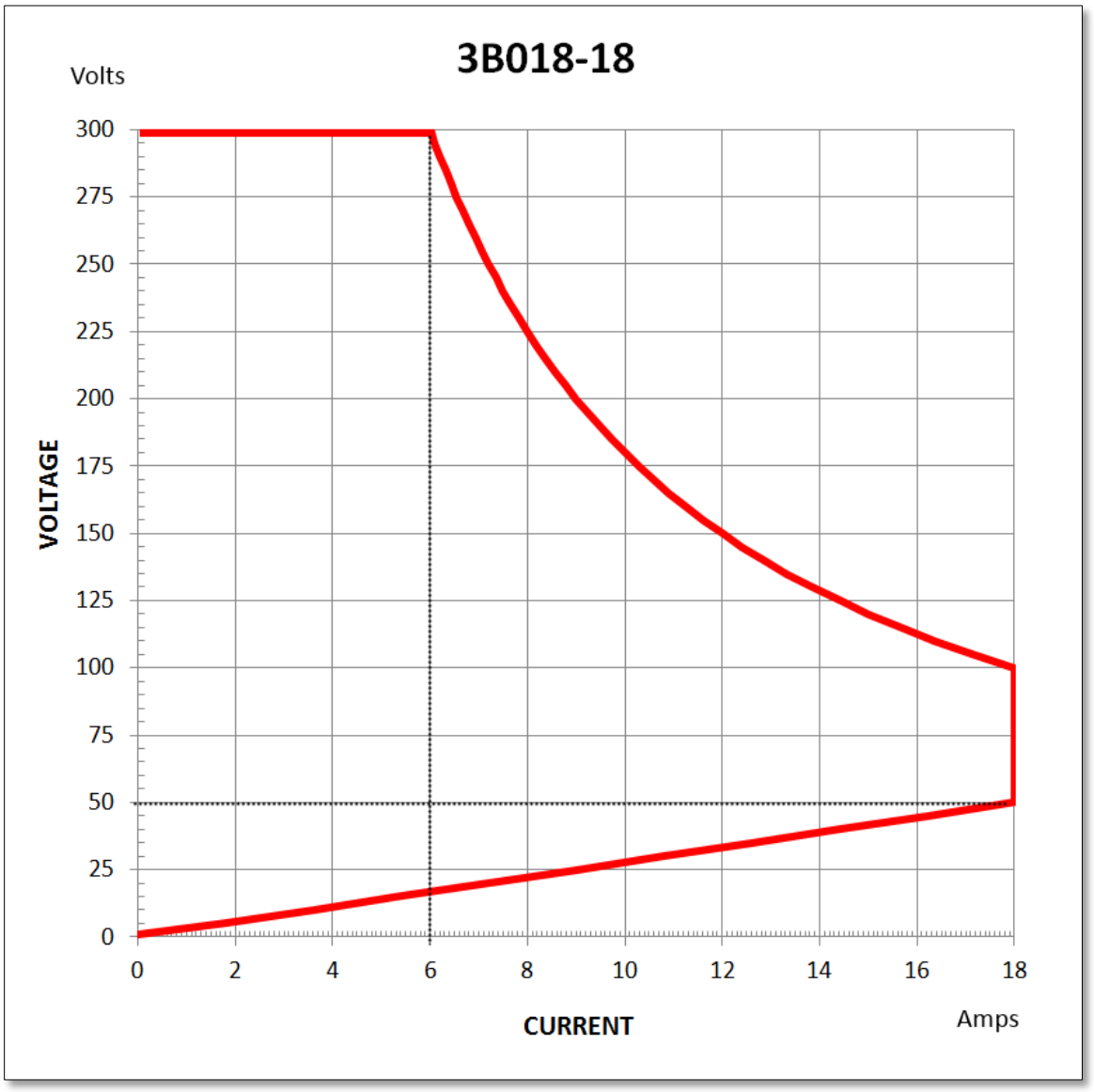



*Figure 4-2: Model 3B018-18 V-I Curve*

### 4.10.3 Model 3B024-24 V-I Curve

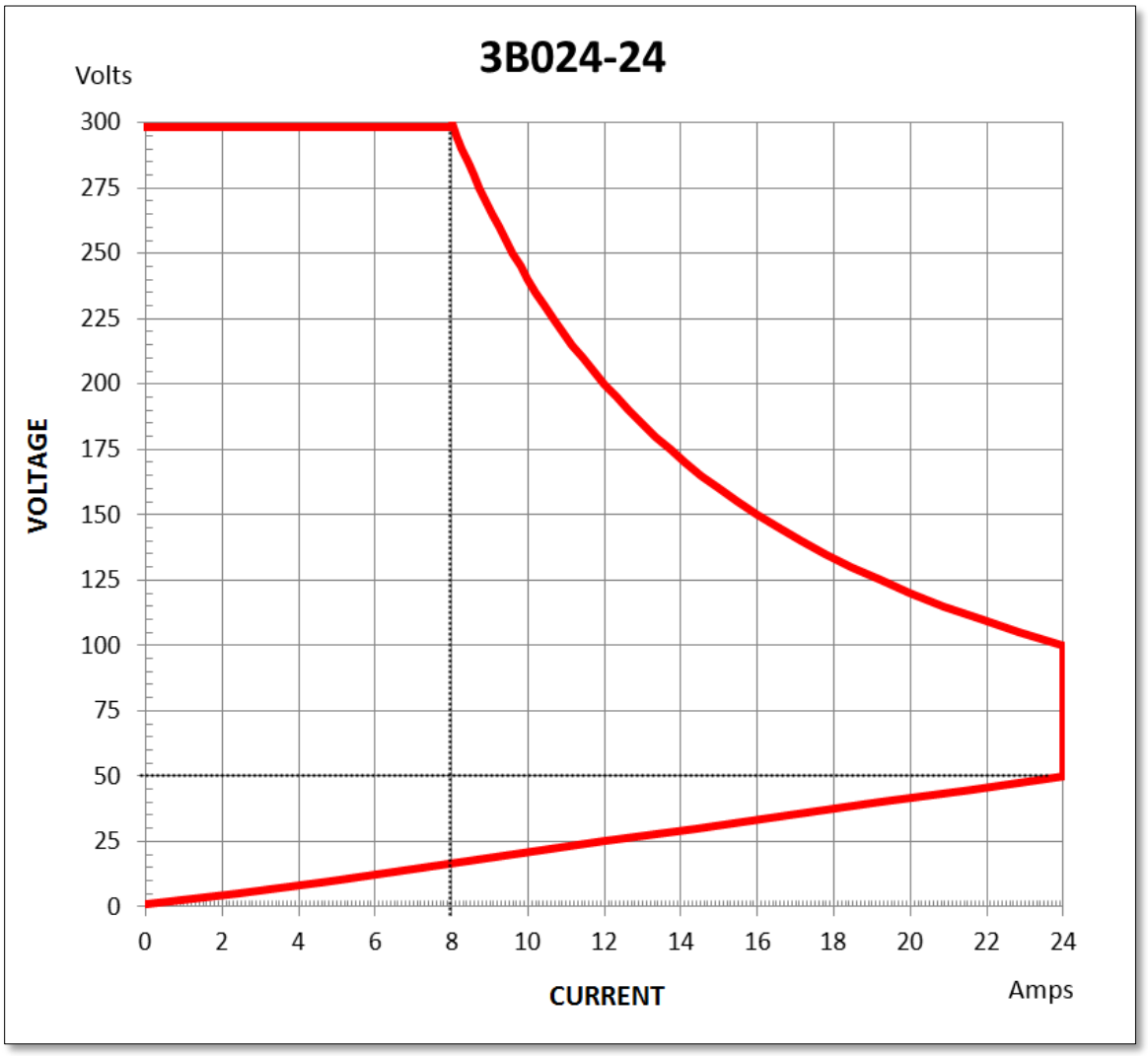



*Figure 4-3: Model 3B024-24 V-I Curve*

### 4.10.4 Model 3B036-36 V-I Curve

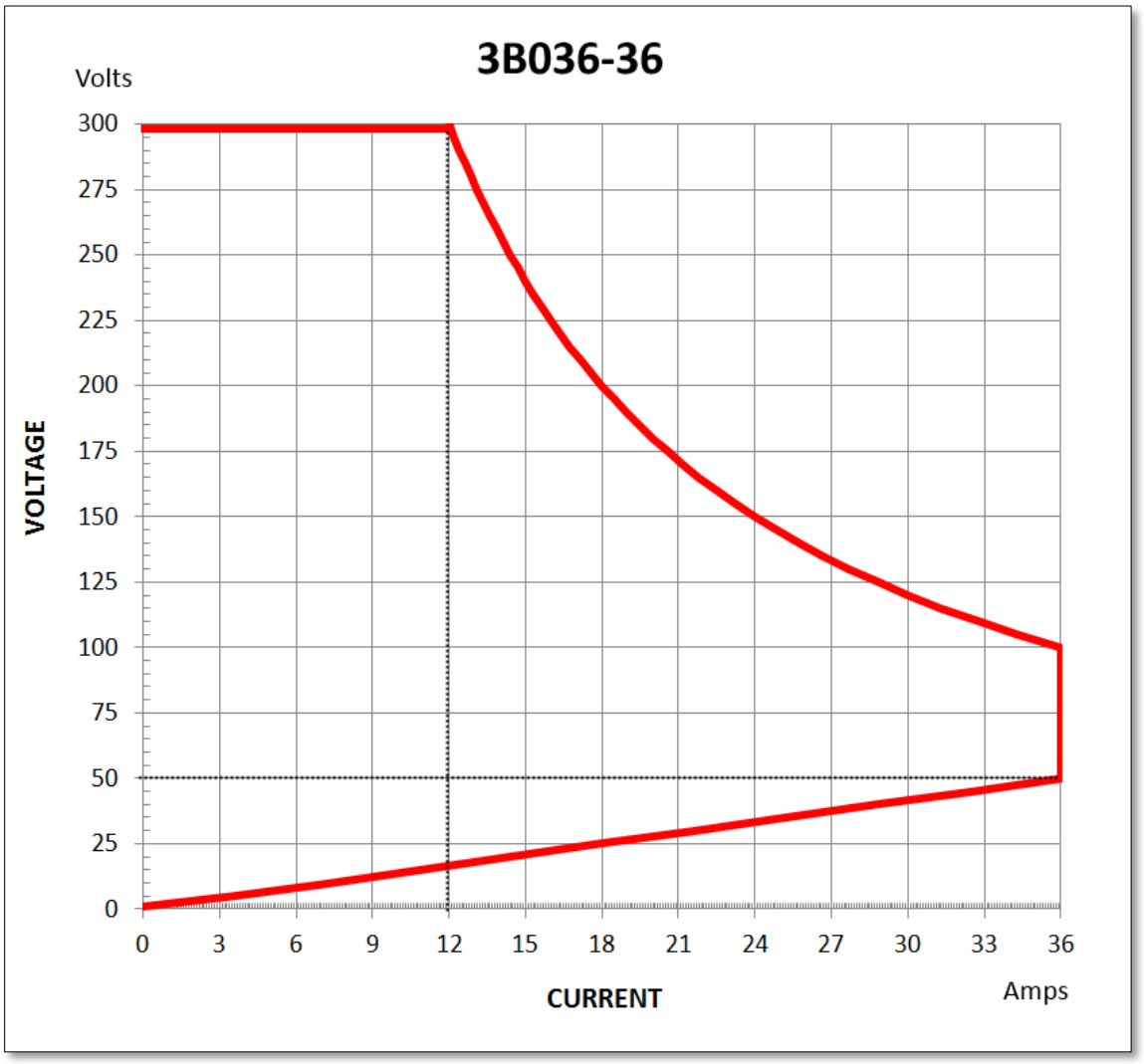



*Figure 4-4: Model 3B036-36 V-I Curve*

### 4.10.5 Model 3B054-54 V-I Curve

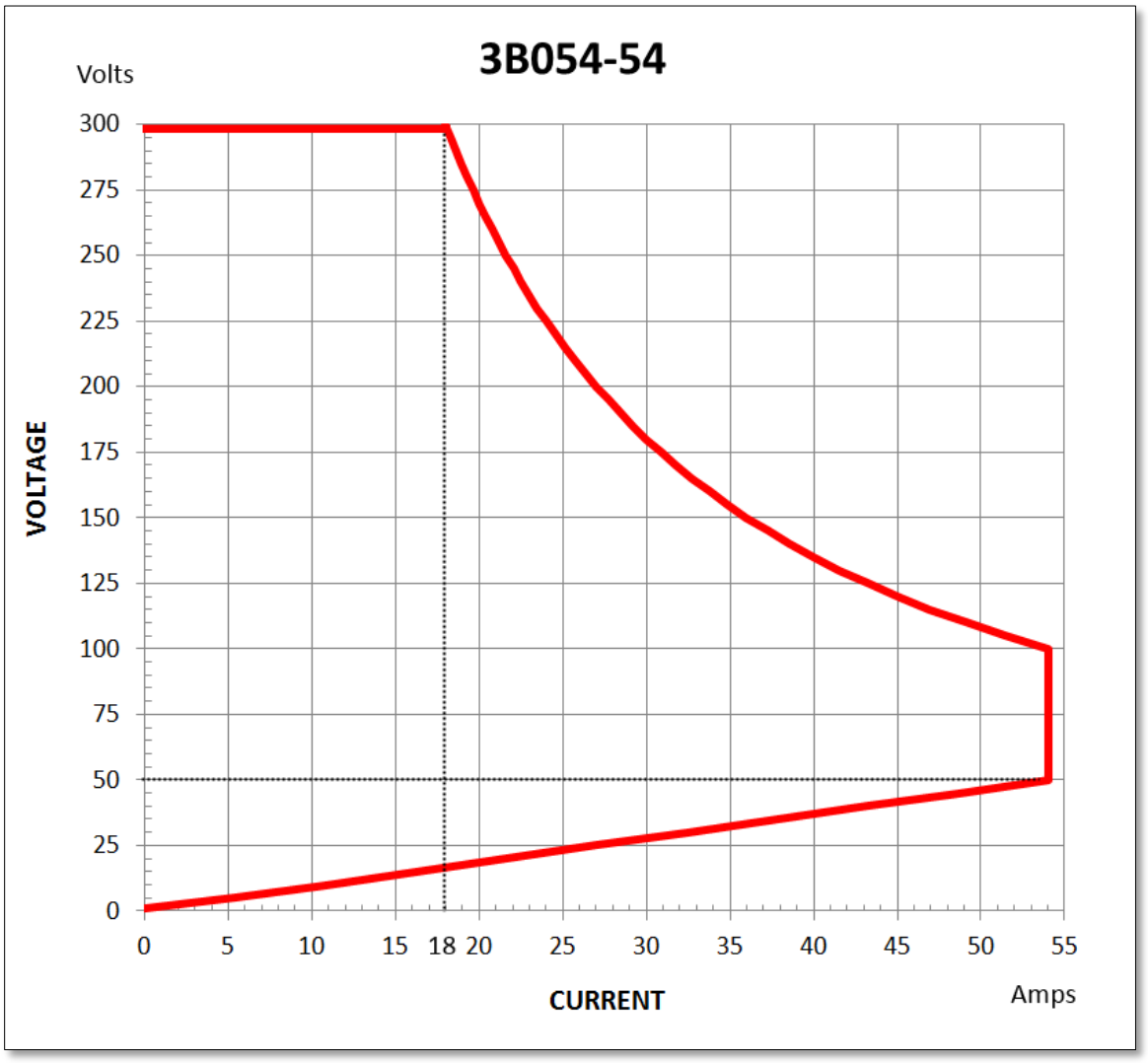



*Figure 4-5: Model 3B054-54 V-I Curve*

### 4.10.6 Model 3B072-72 V-I Curve

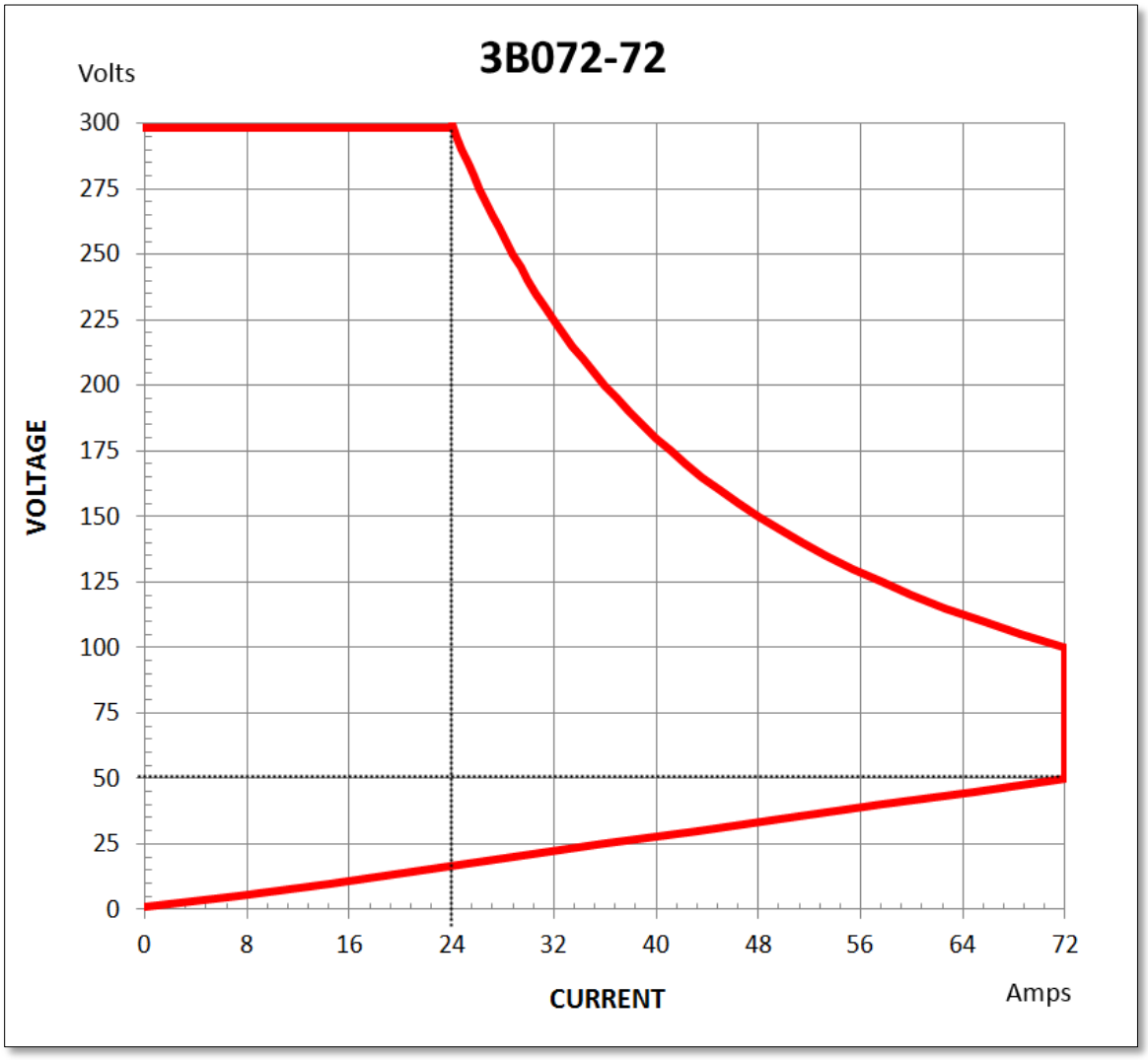



*Figure 4-6: Model 3B072-72 V-I Curve*

### 4.10.7 Model 3B090-90 V-I Curve

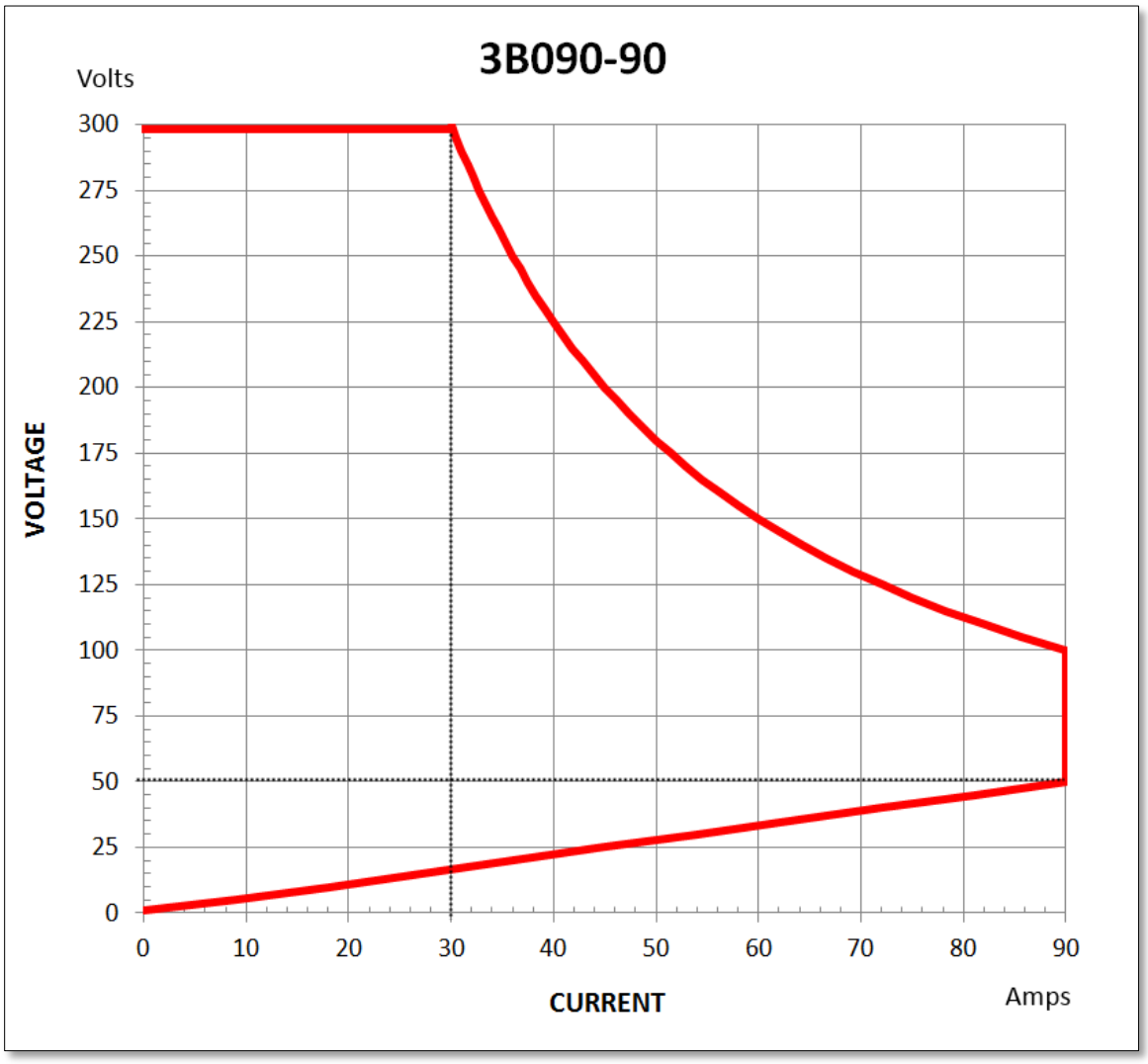



*Figure 4-7: Model 3B090-90 V-I Curve*

### 4.10.8 Model 3B108-108 V-I Curve

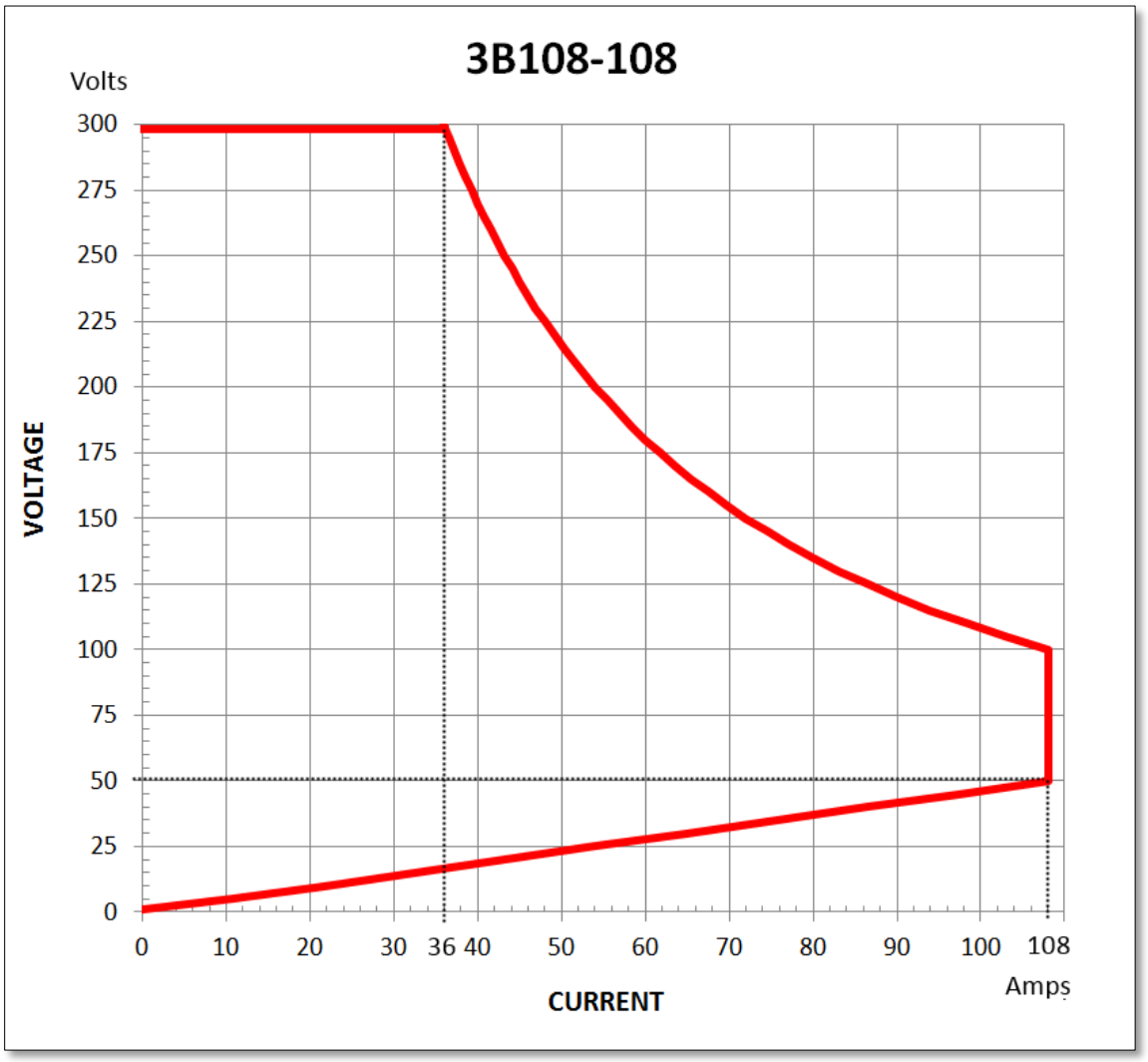



*Figure 4-8: Model 3B108-108 V-I Curve*

### 4.10.9 Model 3B126-126 V-I Curve

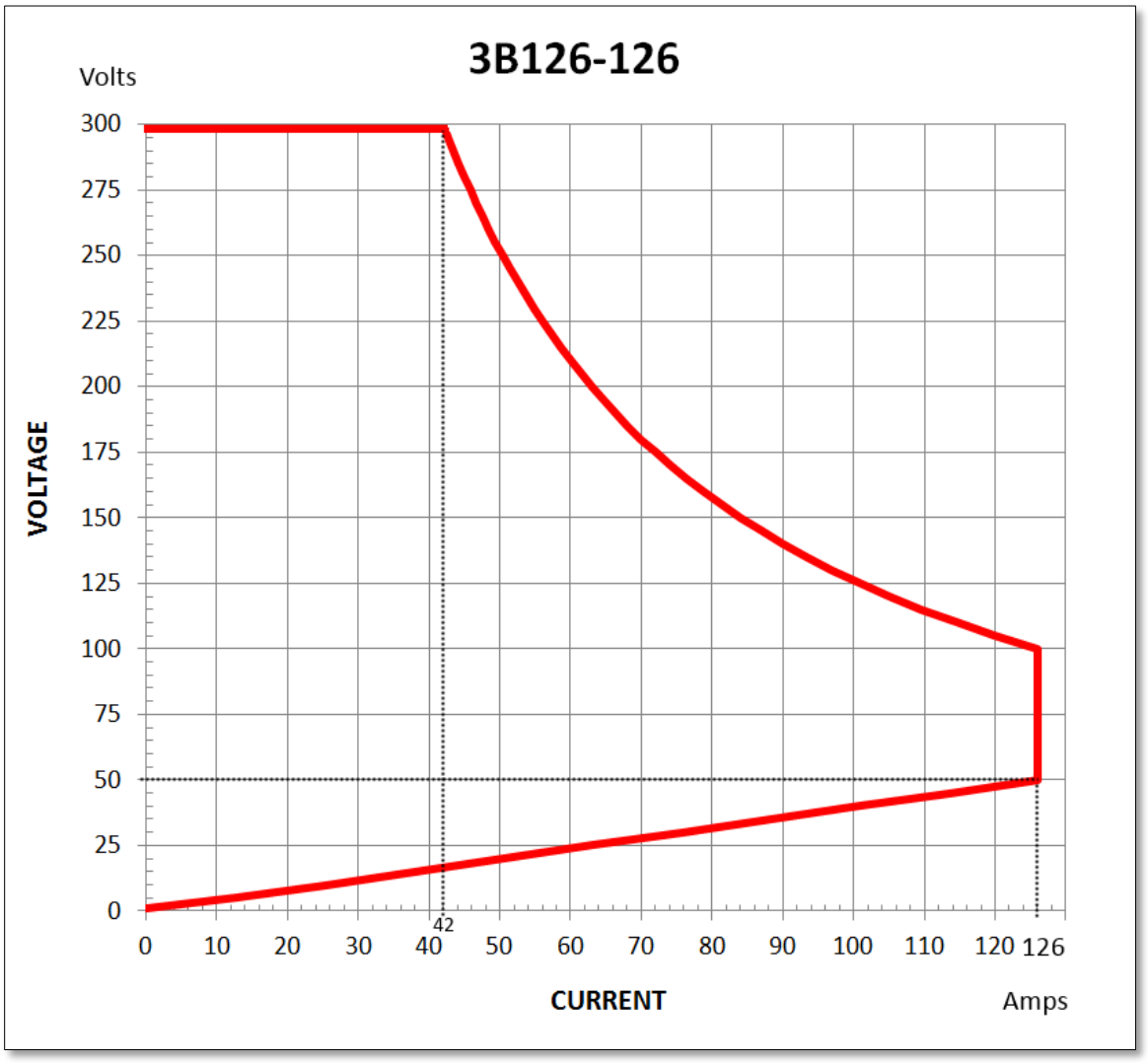



*Figure 4-9: Model 3B126-126 V-I Curve*

# 5 Unpacking and Installation

## 5.1 Inspection

The 3B Series AC & DC loads are carefully inspected before shipment. If instrument damage has occurred during transport, please inform Adaptive Power Systems' nearest sales and service office or representative.

Your 3B Series High Power Electronic Load was shipped with a power cord for the type of outlet used at your location. If the appropriated cord was not included, please contact your nearest Adaptive Power Systems sales office to obtain the correct cord. Refer to the next section to check the line voltage selection and fuse type.

## 5.2 Check Line Voltage

The 3B load can be operated with a 100Vac, 115Vac, 200Vac or 230Vac input as indicated on the label on the rear panel. Make sure that the factory check mark corresponds to your nominal line voltage. Skip this procedure if the label is correctly marked.

1. With the 3B Series mainframe powered OFF, disconnect the AC power cord.
2. Refer to the drawing of the rear panel of the 3B series load in shown in Figure 5-1 to set the AC line selector switch to the proper voltage.

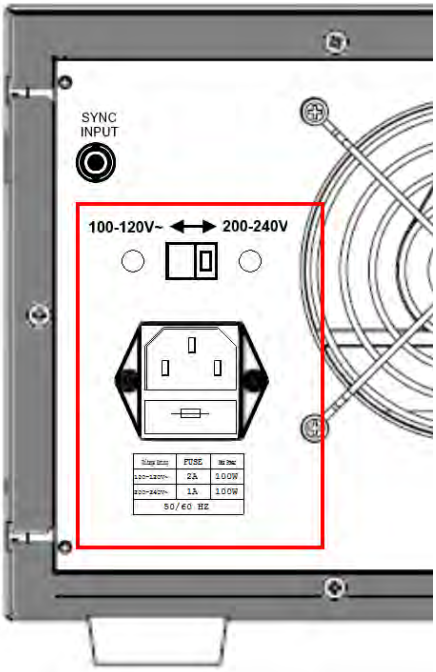



*Figure 5-1: AC Input Voltage Selection*

## 5.3 Input Fuse

This product is fitted with a mains input fuse. If it needs to be replaced, please adhere to the following procedure.

**CAUTION**

**BEFORE replacing the fuse you must switch off the unit and mains power outlet and disconnect the plug of the AC Power cable from the input socket of the load chassis.**

**WARNING**

**If prior to exchanging the fuse, there is any abnormal noise or odor, do not use the unit. Please inform your local sales office to organize repair of the chassis.**

**To avoid the risk of fire or electronic shock the fuse must only be replaced with same type and rating as the original. Any replacement fuse used should meet local national safety standards. Any use of an improper fuse or shorting the Fuse holder is extremely dangerous and is strictly prohibited.**

### 5.3.1 Fuse Replacement Procedure

To replace the AC line input fuse, proceed as follows:

1. Check the rating of the mains input fuse. Replace only with the correct type and rating.
   For 100V/115Vac Input use T2A/250V (5*20mm),
   For 200V/230Vac Input useT1A/250V (5*20mm)
2. The AC line fuse is located below the AC line socket (see *Figure 5-2*). Use a small screwdriver to remove the fuse holder. Replace the failed fuse with the appropriate type and rating according to your mains voltage.
3. Refit the fuse holder and connect the power cord.

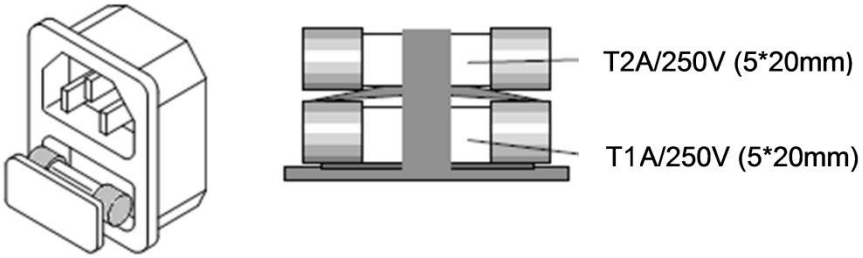



*Figure 5-2: AC Line Fuse Holder Location*

## 5.4 Grounding Requirements

**WARNING**

**SHOCK HAZARD**

The unit is grounded via the AC Input. A line cord with proper Earth Ground pin must be used at all times. Correct grounding of your electrical system infrastructure according to applicable national standards must also be observed.

## 5.5 Chassis Position

The 3B load chassis is equipped with surface protection feet and tilt stands installed and is ready for used as a bench instrument. The feet provide a good viewing angle for bench-top use.

## 5.6 Rack Mounting

The 3B load chassis is designed to be rack mounted in a standard 19 inch rack for system applications. If needed, the feet and tilt-stands may be removed to accommodate zero stacking with other test equipment.

## 5.7 Cleaning

To clean this product uses a soft or slightly damp cloth.

**CAUTION**

**BEFORE you clean the unit, switch the mains power off and disconnect the input line cord.**
**・Please do NOT use any organic solvent capable of changing the nature of the plastic such as benzene or acetone.**
**・Please ensure that no liquid is allowed to penetrate this product.**

## 5.8 Powering Up

The following procedure should be followed before applying mains power:

1. Check that the POWER switch is in the OFF (O) position.
2. Verify that the rear panel voltage selector of the chassis is correctly set.
3. Check that nothing is connected to any of the INPUT (load input terminals) on the front and/or rear panels.
4. Connect the correct AC mains line cord to the load's AC input socket.
5. Plug the line cord plug into a suitable AC outlet socket.
6. Turn on (I) the POWER switch.
7. If the instrument does not turn on for some reason, turn OFF the POWER switch and verify the presence of the correct AC line input voltage using appropriate safety measures.

## 5.9 In Case of Malfunction

In the unlikely event of an instrument malfunction or if the load does not function, please attach a warning tag to the instrument to identify the owner and indicate that service or repair is required. Contact Adaptive Power Systems or its authorized representative to arrange for service.

## 5.10 Load Connection

**WARNING**

**DO NOT EXCEED LOAD INPUT VOLTAGE RATING**

**This instrument does NOT have a means to disconnect its Load input from a connected power supply. If the voltage applied to the Load input exceeds its maximum rating – even if the load is turned completely off – damage to the load WILL occur. Damage caused by exceeded maximum load input voltage under any circumstance is NOT covered by the manufacturer's product warranty. Remove any load input connections when the load is not in use, even when it is turned off.**

When setting up for a new test and connecting any equipment to the AC & DC load, proceed as follows:

1. Check that the output of the equipment under test is **OFF**.
   **Note:** Some power equipment's output may still be energized even if the equipment has been turned off or its output is turned off. This is especially true for DC power supplies.

   **Note:** When working with batteries, it is recommended to provide a suitable disconnect relay or switch so the load connection can be disconnected from the battery for handling purposes.
2. Connect one end of the load wires to the load input terminals jacks on the front panel of the 3B load.
3. Check the polarity of the connections and connect the other end of the load wires to the output terminal of the equipment under test.
4. When connecting multiple 3B loads to the same EUT, makes sure the load wire lengths to each load are the same.

## 5.11 Remote Control Interfaces

The 3B Series load supports both RS232 and GPIB interfaces as a standard feature.

### 5.11.1 GPIB Interface

The GPIB connector is located on the rear panel of the load. This connector allows the load mainframe to be connected to a PC with GPIB controller and other GPIB devices. A GPIB system can be connected in any configuration (star, linear, or both) as long as the following conditions are met:

- The maximum number of devices including the controller is equal or less than 15.
- The maximum length of the GPIB cable is no more than 2 meters.
- The total lead length of all devices connected together totals less than 20 meters.
- Please make sure the lock screws are firmly hand-tightened, use a screwdriver only for the removal of screws. Figure 5-3 shows the rear panel of the 3B Series load. The GPIB address of the load is set from the front panel.

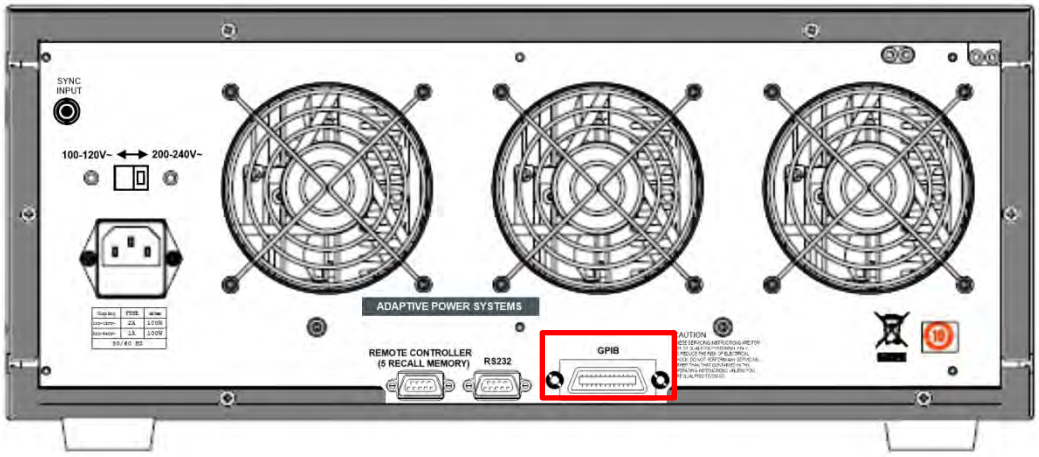
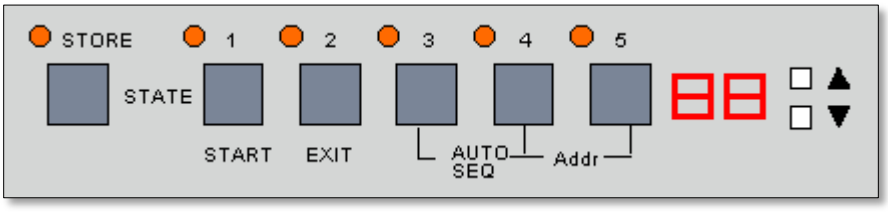



*Figure 5-3: 3B Series Chassis Rear Panel – GPIB Location*

To set the GPIB address, press the “4” and “5” buttons (Addr) at the same time and use the Bank up/down keys to the right of the “5” key to increment or decrement the GPIB address. Available setting range is 0 to 31. Once set, press the “2” (EXIT) key to exit.



### 5.11.2 RS232 Serial Interface

Figure 5-4 shows the RS232 connector (Female) on the rear panel. This connects the load unit to an RS232 port of a computer.

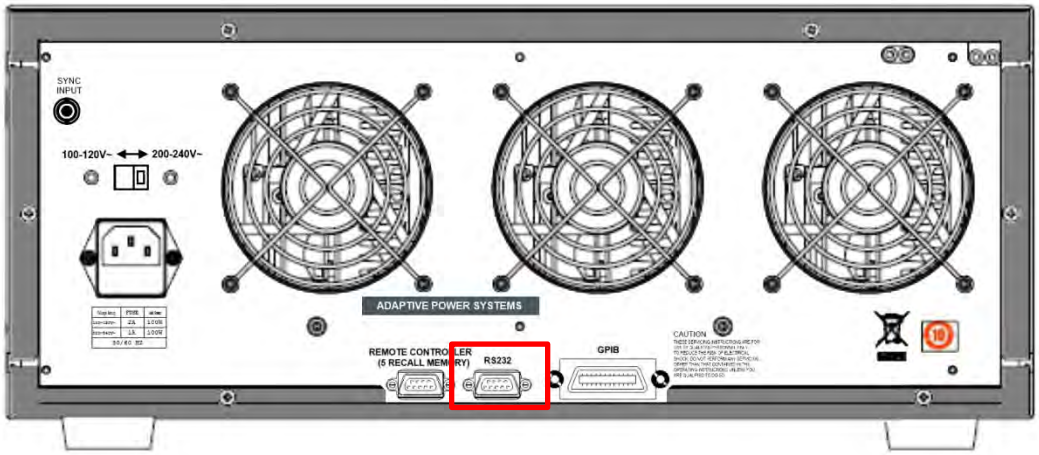



*Figure 5-4: 3B Series Chassis Rear Panel – RS232 Location*

The RS-232 communication settings are fixed as follows:

| | |
|---|---|
| Baud-rate | : 9600 |
| Parity | : none |
| Data bit | : 8 bits |
| Stop bit | : 1 bit |
| Command delay time | : 20 mSec. |

## 5.12 Remote Controller Option Ports

There is one additional D-sub 9 pin connector on the rear panel, located to the left of the RS232 DB9 connector. This Remote **Input** port connects the optional remote controller which replaces the five RECALL option keys on the front panel of the chassis. The LED will be lit if a NoGo (NG) condition occurs.

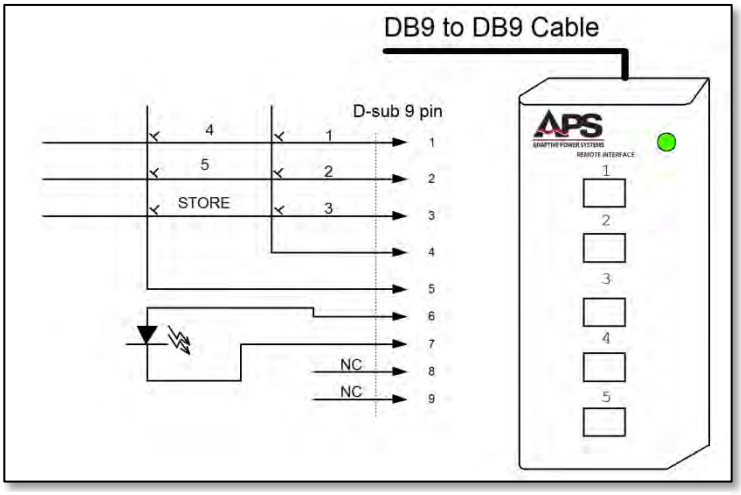



*Figure 5-5: Remote Control Panel*

## 5.13 External Sync Connector

The external sync BNC connector is located in the upper left corner of the rear panel when facing the rear of the load. It is used to provide an external synchronization signal to the load for AC mode operation.

# 6 Front Panel Operation

This Chapter provides an overview of front panel operation for the 3B Series AC & DC loads. For remote control operation, refer to Section 8 “Remote Control Programming” of this manual for an overview of available programming commands.

## 6.1 Front Panel Layout

The front panel layout is shown in Figure 6-1 below. All user controls are directly below the LED display. Load connection, external voltage sense connections and current monitor are arranged along the bottom edge of the front panel.

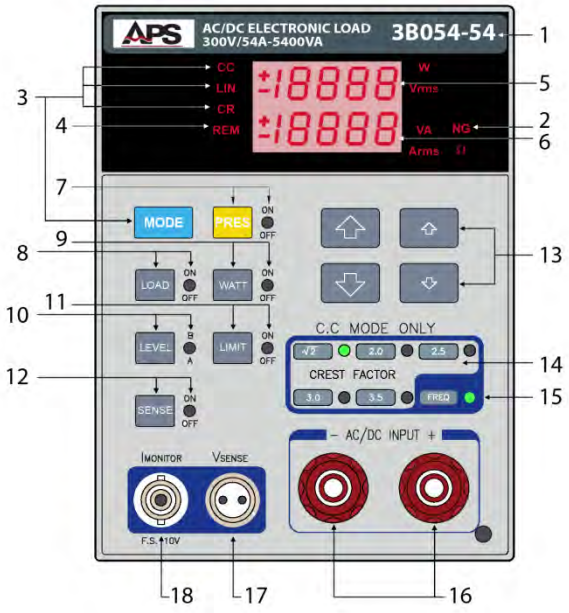

*Figure 6-1: 3B Series Load Front Panel*

Large LED readouts for settings and read-back values are at the top of the control panel. Refer to next section for an overview of all user controls.

## 6.2 User Controls, Displays and Connectors

The following user controls, indicator and displays are common to all 3B Series loads. The purpose and function of each control and indicator is explained in the table below. Refer to figure for the location of each control and indicator.

1. Model Number and ranges
2. Go/NoGo indicator illuminates if upper or lower limit settings are exceeded
3. Operating Mode Indicators and MODE key
4. REMOTE state indicator
5. Multi-purpose 4½ digit display – Voltage or Power
6. Multi-purpose 4½ digit display – Current or Apparent Power
7. Preset Mode On/Off key Controls settings shown on LED display
8. LOAD ON/OFF button and indicator
9. WATT display mode On/Off key and indicator




10. Level A or B Setting Toggle key and indicator
11. Limit Mode On/Off and indicator
12. Internal or External Voltage Sense Mode selection key and indicator
13. Rough and Fine Setting Adjustment Up/Down keys
14. Crest Factor Selection keys
15. Frequency, BANK and SYNC setting key
16. Load Input Terminals
17. External Voltage Sense Connector
18. Current Monitor Output BNC.

*Figure 6-2: Front Panel User Controls and Indicators*

The various controls and indicators are explained in more detail in the table below. The Item numbers correspond to the indices in Figure 6-2 above.

| Key # | Description | |
|---|---|---|
| **1** | Indicates the **model number** and key performance specifications of the load. | |
| **2** | **Go/NoGo** indicator illuminates when upper or lower limit settings for Voltage, Current, Power or VA are exceeded. | |
| **3** | **MODE key and annunciators**<br>There are three operating modes can be selected by pressing the "MODE" key.<br>The sequence is Constant Current (CC), Linear Constant Current (LIN) and Constant Resistance (CR) and then repeats. When pressing the "MODE" key, the CC, LIN and CR mode indicator will be lit respectively when the appropriate operating mode is selected.<br>The operating theorem of CC, LIN and CR mode is described in Section 3.2, "Operating Modes". | |
| **4** | The Remote Indicator (REM) is used to indicate the status of remote operation. Front panel operation is locked out while the remote annunciator is ON. In case of Local mode or manual operation, the Remote annunciator is OFF | |
| **5** | This is the upper 4½ digit multifunction display. It's function depends on the operating mode the load is in as described in the next rows: | |
| | Default Condition | This display will show the voltage at the load connection (internal sense) or at the load (external sense) Vrms. |

| Key # | Description | |
|---|---|---|
| | WATT ON mode | In WATT mode (see 9), the upper display shows the measured true power consumed by the load in Watts. |
| | LIMIT ON mode | In LIMIT mode, the upper display shows the UPPER limit settings for No/Go mode measurement limits in the following sequence:<br>Vrms ⇨ Arms ⇨ W ⇨ VA. |
| | PROTECTION mode | If an over voltage condition has triggered the OVP protection mode, the upper display will display “oVP” |
| | FREQ ON mode | If FREQ mode is set to ON (see 15), the Frequency, Bank and Sync setting information will be displayed on the upper LED display in the following order:<br>Frequency setting “FrEq” ⇨ Bank selection “bAn” ⇨ SYNC selection “Sync”. |
| **6** | This is the lower 4½ digit multifunction display. It’s function depends on the operating mode the load is in as described in the next rows: | |
| | PRESET OFF mode | The lower display will show the load current in Arms. |
| | PRESET ON mode | The lower display will show the preset values for manual or remote control mode for the active operating mode:<br>CC and LIN Modes: Displays set value of CC level A and B in Arms.<br>CR Mode: Displays set value of R level A and B in Ω.<br>Protection Mode: If over current, over power or over temperature conditions are detected, this display will show “oCP”, “oPP” or “oTP”. |
| | LIMIT ON mode | In LIMIT mode, the upper display shows the LOWER limit settings for No/Go mode measurement limits in the following sequence:<br>Vrms ⇨ Arms ⇨ W ⇨ VA. |
| | PROTECTION mode | If an over voltage condition has triggered the OVP protection mode, the upper display will display “oVP” |
| | FREQ ON mode | If FREQ mode is set to ON (see 15), the lower display will show:<br>Frequency Frequency setting as DC or 0.1 through 400Hz.<br>Bank 0 through 10<br>Sync: ON or OFF |
| **7** | **PRESet Key and annunciator**<br>Pressing the “PRES” key will toggle the PRESET mode ON or OFF. When ON, the A and B set values for the selected mode can be set and are displayed on the LED read-outs.<br>When OFF, it means the set A and B levels are the active setting for the load. In PRESET OFF condition, the upper 4 1/2 digit monitor displays the voltage input to load in Vrms while the lower 4 1/2 digit monitor displays the current flowing into electronic load in Arms.<br>In PRESET ON condition, the PRES LED indicator is lit and both upper and lower 4 1/2 digit monitors will have different displays depending on selected operating mode as shown below: | |
| | CC mode | The set values of Level A / B load current are displayed on the lower 4 1/2 digit monitor in Arms. “Arms” annunciator is ON. |
| | LIN mode | The set values of Level A / B load current are displayed on the lower 4 1/2 digit monitor in Arms. “Arms” annunciator is ON. |
| | CR mode | The set values of Level A / B load resistance are displayed on the lower 4 1/2 digit monitor in Ω. The “Ω “annunciator is ON. |

<table>
<tr><th>Key #</th><th>Description</th></tr>
<tr><td>8</td><td>LOAD ON/OFF key and annunciator<br>The LOAD key is used toggle the electronic load ON or OFF. When OFF, the load will sink no current even if a EUT is connected. It remains in a high impedance state.<br>When the load is turned ON, it will start sinking current based on any input voltage present that is within range, operating mode setting and A/B setting parameters.<br>The LOAD LED annunciator will be lit when the LOAD is engaged (ON), even if no EUT is connected and no current is flowing into the load.</td></tr>
<tr><td>9</td><td>WATT key and Indicator<br>Pressing the WATT key toggles the WATT mode on or off. The data displayed on the two numeric displays is a function for both WATT and PRES mode as follows:
<table>
<tr><td>PRESET OFF</td><td>WATT ON:<br><br><br><br>WATT OFF</td><td>Watt mode is ON and the upper display shows the true power consumed by the load in Watt, while the lower display shows the apparent power consumed by the load in VA.<br>Watt mode is OFF and the upper display shows the voltage in Vrms, while the lower display shows the current sunk by load in Arms.</td></tr>
<tr><td rowspan="4">PRESET ON</td><td colspan="2">In PRESET ON condition, the PRES LED indicator is lit and both upper and lower 4 1/2 digit monitors will have different displays depending on selected operating mode as shown below:</td></tr>
<tr><td>CC mode</td><td>The set values of Level A / B load current are displayed on the lower 4 1/2 digit monitor in Arms. “Arms” annunciator is ON.</td></tr>
<tr><td>LIN mode</td><td>The set values of Level A / B load current are displayed on the lower 4 1/2 digit monitor in Arms. “Arms” annunciator is ON.</td></tr>
<tr><td>CR mode</td><td>The set values of Level A / B load resistance are displayed on the lower 4 1/2 digit monitor in Ω. The “Ω “annunciator is ON.</td></tr>
</table></td></tr>
<tr><td>10</td><td>LEVEL A/B key and annunciator<br>Pressing the LEVEL key will toggle load settings between A (LED indicator off) and B values (LED indicator lit).<br>This feature allows a pair of settings to be saved to memory for rapid transition switching between current or resistance settings.</td></tr>
</table>

| Key # | Description |
|---|---|
| 11 | **LIMIT key and annunciator**<br>Pressing the LIMIT key will place the load in the LIMIT ON state. This allows changes to be made to the upper and lower measurement test limits for Go/NoGo operation. The display functions in LIMIT ON Mode are selected in sequence by repeatedly pressing the LIMIT key as follows:<br>Voltage Limit: Upper display shows upper voltage limit setting in Vrms, Lower display shows lower voltage limit setting in Vrms.<br>Current Limit: Upper display shows upper current limit setting in Arms, Lower display shows lower current limit setting in Arms.<br>Power Limit: Upper display shows upper true power limit setting in Watts, Lower display shows lower true power limit setting in Watts.<br>VA Limit: Upper display shows upper apparent power limit setting in VA, Lower display shows lower apparent power limit setting in VA.<br>Refer to section for key #13 below for adjusting upper and lower limit values.<br><br>After five presses of the LIMIT key, the LIMIT annunciator will turn off and the load returns to the LIMIT OFF state. |
| 12 | **SENSE key and annunciator**<br>The voltmeter and internal trigger circuit of the 3B Series load can sense either at the load terminals or at the EUT, if the external voltage sense cabling is connected to the point of load. The SENSE key switches between INTERNAL (annunciator OFF) and EXTERNAL (annunciator ON) voltage sense modes. |
| 13 | **Coarse and Fine Tuning Up/Down Arrow keys**<br>There are two sets of up/down arrow keys directly below the display area. The larger set of keys allows coarse setting adjustments to be made. What parameter settings they adjust depends on the selected mode as follows:<br>PRESET ON: ⇧ ⇩ Coarse increment or decrement of load setting; ⇧ ⇩ Fine increment or decrement of load setting<br>LIMIT ON: ⇧ ⇩ Increment or decrement UPPER limit settings; ⇧ ⇩ Increment or decrement LOWER limit settings<br>FREQ ON: Depends on AC parameter selected<br>Frequency (FrEq): ⇧ ⇩ Coarse increment or decrement of Frequency setting; ⇧ ⇩ Fine increment or decrement of Frequency setting<br>Bank (bAn): ⇧ ⇩ Fine increment or decrement of bank selection (either set of keys); ⇧ ⇩ Fine increment or decrement of bank selection (either set of keys)<br>Sync: ⇧ ⇧ External Sync ON; ⇩ ⇩ External Sync OFF |
| 14 | **√2, 2.0, 2.5, 3.0, 3.5 Key and annunciators**<br>These 5 keys only function while in CC mode of operation. All keys are disabled in either LIN or CR modes. They are used to select from 5 different Crest Factor values for the AC load current from the selected waveform Bank.<br><br>**Note:** The CF value decals on these keys only reflect the actual CF value stored in bank zero (0). For all other bank selections, the actual CF value may be different. Refer to Section 6.5.2, "Waveform and Crest Factor Bank Selection" for details. |

| Key # | Description | |
|---|---|---|
| 15 | **FREQ key and annunciator**<br>The function of this key depends on the selected operating mode as follows: | |
| | CC mode | After pressing the FREQ key, the annunciator will turn on. Parameters are selected in the following order by repeatedly pressing the FREQ key:<br>FREQ ⇨ BANK (except in DC mode) ⇨ SYNC ⇨ Off<br><br>Available AC parameter setting ranges are:<br>FREQ DC, 0.1 to 400 Hz.<br>BANK 0 through 10 for 11 banks total<br>SYNC ON = External Sync, OFF = Internal Sync |
| | LIN & CR modes | After pressing the FREQ key, the annunciator will turn on. Pressing the FREQ key again will turn it off. |
| 16 | **AC or DC Load Input Connections**<br>Before connecting any source or supply to the 3B load banana jack connectors, make sure that the rated specification of the voltage and current of the 3B Series model will not be exceeded. Before wiring the load input, please refer to Section 7.1, "INPUT Terminals" to avoid damaging the internal circuits and connectors. | |
| 17 | **V Sense Connector**<br>Refer to Section 7.4, on "Voltage Sense Input Terminals" for information on external voltage sense connections. | |
| 18 | **I-Monitor Output BNC**<br>Refer to Section 7.5, on "Current Output Monitor (I-Monitor)" for further information on using this feature. | |

*Table 6-1: Front Panel Display and Keyboard Functions*

## 6.3 Coarse and fine Adjustment Ranges

The maximum load current of 3A loads can be adjusted depending on the model used. The relationship between the adjustment variation of the load current or resolution and cursors up/down buttons is shown in the tables below for each available load model.

During operation, when the time for depressing one of the four buttons, e.g., course tuning, fine tuning, increment and decrement, exceeds one second, the resolution of load current adjustment changes every 10ms, e.g., the rate of change of the load current will increase so that reaching the desired end value can be completed in the shortest amount of time. This occurs as long as neither minimum nor maximum set values are reached and key pressing is not interrupted.

| Model 3B012-12 | | Range I | | Range II | |
|---|---|---|---|---|---|
| FULL SCALE LOAD CURRENT | | 6 A | | 12 A | |
| CURRENT | RANGE | 12.000 A | | | |
| METER | RESOLUTION | 0.001 A | | | |
| COURSE/FINE LOAD CURRENT ADJUSTMENT KEY | | ↑ | ↑ | ↑ | ↑ |
| KEY'S STEP RESOLUTION | | 15 mA | 1.5 mA | 30 mA | 3 mA |

*Table 6-2: Model 3B012-12 Course and Fine Adjustments*

| Model 3B018-18 | | Range I | | Range II | |
|---|---|---|---|---|---|
| FULL SCALE LOAD CURRENT | | 9 A | | 18 A | |
| CURRENT | RANGE | 18.000 A | | | |
| METER | RESOLUTION | 0.001 A | | | |
| COURSE/FINE LOAD CURRENT ADJUSTMENT KEY | | ↑ | ↑ | ↑ | ↑ |
| KEY'S STEP RESOLUTION | | 22.5 mA | 2.2 mA | 45 mA | 4.5 mA |

*Table 6-3: Model 3B018-18 Course and Fine Adjustments*

| Model 3B024-24 | | Range I | | Range II | |
|---|---|---|---|---|---|
| FULL SCALE LOAD CURRENT | | 12 A | | 24 A | |
| CURRENT | RANGE | 36.000 A | | | |
| METER | RESOLUTION | 0.01 A | | | |
| COURSE/FINE LOAD CURRENT ADJUSTMENT KEY | | ↑ | ↑ | ↑ | ↑ |
| KEY'S STEP RESOLUTION | | 30 mA | 3 mA | 60 mA | 6 mA |

*Table 6-4: Model 3B024-24 Course and Fine Adjustments*

| Model 3B036-36 | | Range I | | Range II | |
|---|---|---|---|---|---|
| FULL SCALE LOAD CURRENT | | 18 A | | 36 A | |
| CURRENT | RANGE | 36.000 A | | | |
| METER | RESOLUTION | 0.01 A | | | |
| COURSE/FINE LOAD CURRENT ADJUSTMENT KEY | | ↑ | ↑ | ↑ | ↑ |
| KEY'S STEP RESOLUTION | | 45 mA | 4.5 mA | 90 mA | 9 mA |

*Table 6-5: Model 3B036-36 Course and Fine Adjustments*

| Model 3B054-54 | | Range I | | Range II | |
|---|---|---|---|---|---|
| FULL SCALE LOAD CURRENT | | 27 A | | 54 A | |
| CURRENT | RANGE | 54.000 A | | | |
| METER | RESOLUTION | 0.012 A | | | |
| COURSE/FINE LOAD CURRENT ADJUSTMENT KEY | | ↑ | ↑ | ↑ | ↑ |
| KEY'S STEP RESOLUTION | | 67.5 mA | 6.75 mA | 135 mA | 13.5 mA |

*Table 6-6: Model 3B054-54 Course and Fine Adjustments*

| Model 3B072-72 | | Range I | | Range II | |
|---|---|---|---|---|---|
| FULL SCALE LOAD CURRENT | | 36 A | | 72 A | |
| CURRENT | RANGE | 72.000 A | | | |
| METER | RESOLUTION | 0.012 A | | | |
| COURSE/FINE LOAD CURRENT ADJUSTMENT KEY | | ↑ | ↑ | ↑ | ↑ |
| KEY'S STEP RESOLUTION | | 90 mA | 9 mA | 180 mA | 18 mA |

*Table 6-7: Model 3B072-72 Course and Fine Adjustments*

| Model 3B090-90 | | Range I | | Range II | |
|---|---|---|---|---|---|
| FULL SCALE LOAD CURRENT | | 45 A | | 90 A | |
| CURRENT | RANGE | 90.000 A | | | |
| METER | RESOLUTION | 0.012 A | | | |
| COURSE/FINE LOAD CURRENT ADJUSTMENT KEY | | ↑ | ↑ | ↑ | ↑ |
| KEY'S STEP RESOLUTION | | 112.5 mA | 11.25 mA | 225 mA | 22.5 mA |

*Table 6-8: Model 3B090-90 Course and Fine Adjustments*

| Model 3B108-108 | | Range I | | Range II | |
|---|---|---|---|---|---|
| FULL SCALE LOAD CURRENT | | 54 A | | 108 A | |
| CURRENT | RANGE | 108.000 A | | | |
| METER | RESOLUTION | 0.012 A | | | |
| COURSE/FINE LOAD CURRENT ADJUSTMENT KEY | | ↑ | ↑ | ↑ | ↑ |
| KEY'S STEP RESOLUTION | | 135 mA | 13.5 mA | 270 mA | 27 mA |

*Table 6-9: Model 3B108-108 Course and Fine Adjustments*

| Model 3B126-126 | | Range I | | Range II | |
|---|---|---|---|---|---|
| FULL SCALE LOAD CURRENT | | 63 A | | 126 A | |
| CURRENT | RANGE | 126.000 A | | | |
| METER | RESOLUTION | 0.014 A | | | |
| COURSE/FINE LOAD CURRENT ADJUSTMENT KEY | | ↑ | ↑ | ↑ | ↑ |
| KEY'S STEP RESOLUTION | | 157.5 mA | 15.75 mA | 315 mA | 31.5 mA |

*Table 6-10: Model 3B126-126 Course and Fine Adjustments*

## 6.4 AC or DC Load Mode Selection

The 3B Series loads are capable of operating in both AC and DC mode. The mode of operation is determined by the frequency of the AC voltage sensed as follows:

### 6.4.1 AC Mode Setting

For use as an AC load, the frequency setting of the load must be set in accordance with the frequency of EUT. Even if the output frequency of the EUT is 50 Hz, the frequency setting of the electronic load must still be set to 50.0 Hz using the FREQ function key or command. (See Section 6.1, “Front Panel Layout”.

### 6.4.2 DC Mode Setting

For use as a DC load, the electronic load must be set to DC. DC mode is set using the FREQ key. When DC is set, the Bank function will not be available. (Fixed to DC, the display will not show BANK).

## 6.5 AC Load Parameter Settings

The following parameters are specific to using the 3B Series in AC load mode as opposed to DC load mode and only apply to AC applications.

- Frequency Setting
- Waveform and Crest Factor Bank Selection
- Synchronization Source Setting

### 6.5.1 Frequency Setting

The range for the frequency setting of the 3B Series load is either DC or from 0.1 to 400 Hz. If a value below 40Hz is entered, the frequency setting will automatically be set to DC.

Setting the expected AC frequency of the AC input voltage allows the 3B Series load to synchronize to it properly using its internal synchronization circuits.

Once set, the SYNC setting has to be set to OFF for the frequency setting to be valid.

**Remote Control Mode**

When using the remote control interface, it is possible to auto-detect the AC input voltage frequency by sending the following command.

**AFREQ**

Purpose: To enable or disable the auto-frequency detection function.

Command syntax: AFREQ {SP} {0 | 1 | OFF | ON} {;|NL}

**Description:**

AFREQ ON Enables the auto frequency detect function. Load will sense input voltage frequency and synchronized the load current to the input voltage. In this mode of operation, the regular “FREQ” command is ineffective.

AFREQ OFF Disables the auto frequency detect function. This requires the frequency to be set using the “FREQ” command. When AFREQ mode is turned off, the set frequency will be fixed to the last detected input frequency.

For Example：

AFREQ ON

AFREQ OFF

### 6.5.2 Waveform and Crest Factor Bank Selection

The 3B Series load provides 11 built-in stored waveform sets at various crest factors totaling 55 waveforms. The content of Bank memory table is shown in Table 6-11 below. Details of various waveform types are further in the next few paragraphs.

| Waveform | BANK | WAVE = A | WAVE = B | WAVE = C | WAVE = D | WAVE = E | Phase Shift |
|---|---|---|---|---|---|---|---|
| **Sine wave** | 0 | √2 | 2.0 | 2.5 | 3.0 | 3.5 | |
| | 1 | 1.5 | 1.6 | 1.7 | 1.8 | 1.9 | |
| | 2 | 3.0 | 3.1 | 3.2 | 3.3 | 3.4 | |
| **C.F. = 2** | 3 | P.F. = -0.85 | P.F. = -0.80 | P.F. = -0.75 | P.F. = -0.70 | P.F. = -0.65 | Lagging PF |
| **C.F. = 2.5** | 4 | P.F. = -0.75 | P.F. = -0.70 | P.F. = -0.65 | P.F. = -0.50 | P.F. = -0.40 | |
| **C.F. = 3.5** | 5 | P.F. = -0.50 | P.F. = -0.45 | P.F. = -0.40 | P.F. = -0.35 | P.F. = -0.30 | |
| **C.F. = 2** | 6 | P.F. = +0.85 | P.F. = +0.80 | P.F. = +0.75 | P.F. = +0.70 | P.F. = +0.65 | Leading PF |
| **C.F. = 2.5** | 7 | P.F. = +0.75 | P.F. = +0.70 | P.F. = +0.65 | P.F. = +0.50 | P.F. = +0.40 | |
| **C.F. = 3.5** | 8 | P.F. = +0.50 | P.F. = +0.45 | P.F. = +0.40 | P.F. = +0.35 | P.F. = +0.30 | |
| **Square** | 9 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | |
| **DC** | 10 | √2 dc | 2 dc | 2.5 dc | 3.0 dc | 3.5 dc | |

*Table 6-11: Waveform Bank Data Table*

**Note:** If the Frequency setting is set to DC, the wave form information is fixed at the DC level. The Bank selection function is not available unless Frequency is set to AC.

**Banks 0, 1 & 2 Sinusoidal Waveforms**

Current crest factor (C.F.) values for use with a sinusoidal AC input voltage are contained in the first 15 locations, banks 0 through 2, each containing five C.F values ranging from √2 to 3.5. These wave shapes are shown below.

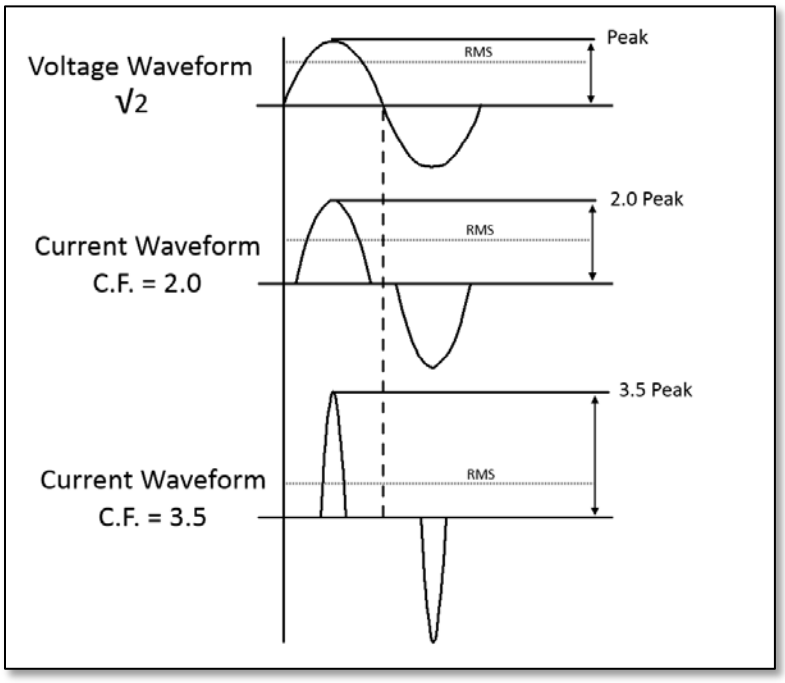



*Figure 6-3: Waveforms in Banks 0 through 2*

### Banks 3, 4 & 5 Sinusoidal Waveforms with Negative Displacement Power Factor

Banks 3 through 5 contain waveforms at various crest factor values in the range of 2.0 to 3.5 with negative displacement power factor values from -0.85 to -0.30.

Total is 15 waveforms. Waveform definition is shown in below.

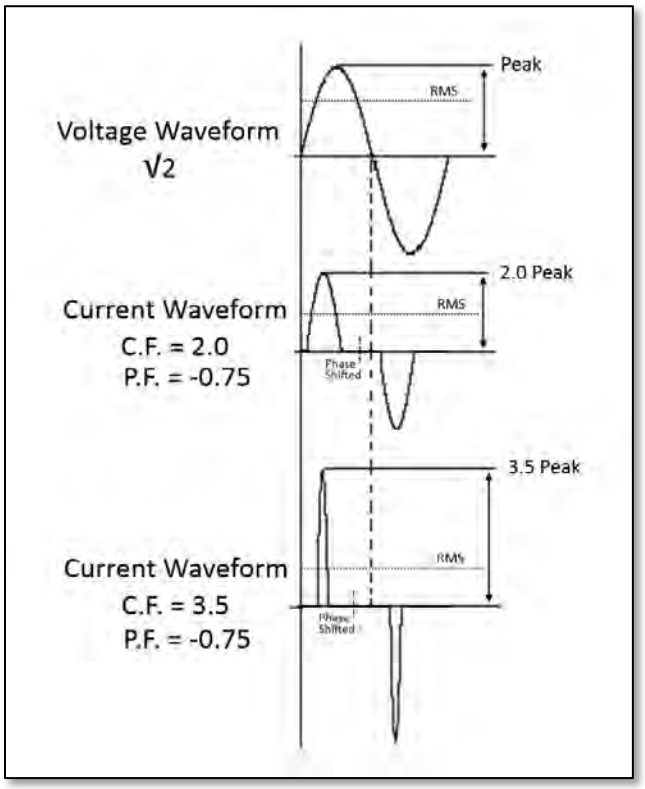



*Figure 6-4: Waveforms in Banks 3 through 5*

### Banks 6, 7 & 8 Sinusoidal Waveforms with Positive Displacement Power Factor

Banks 6 through 8 contain waveforms at various crest factor values in the range of 2.0 to 3.5 with positive displacement power factor values from +0.85 to +0.30.

Total is 15 waveforms. Waveform definition is shown in below.

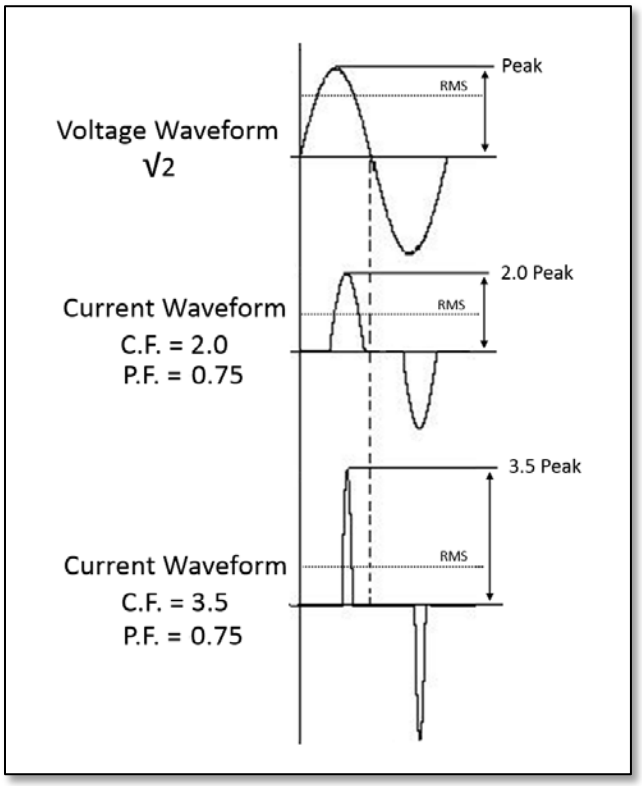



*Figure 6-5: Waveforms in Banks 6 through 8*

**Bank 9 Square Waveforms**

Bank 9 contains square waveforms at various crest factor values in the range of 1.0 to 1.4.

Total is 5 waveforms. Waveform definition is shown in below.

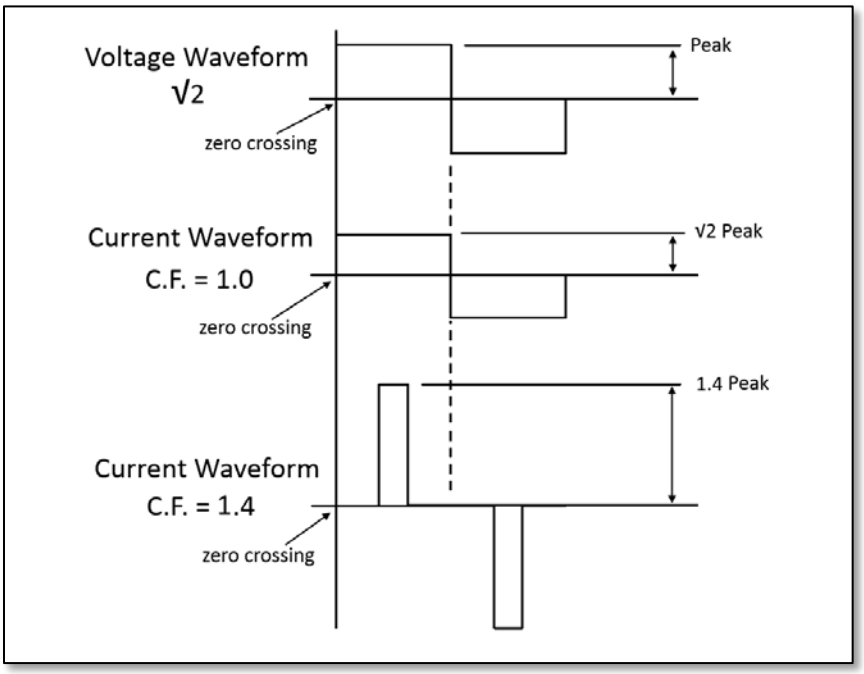



*Figure 6-6: Square Waveforms Bank 9*

**Bank 10 DC Waveforms**

Bank 10 contains DC waveforms at various crest factor values in the range of√2 to 3.5.

Total is 5 waveforms. Waveform definition is shown in below.

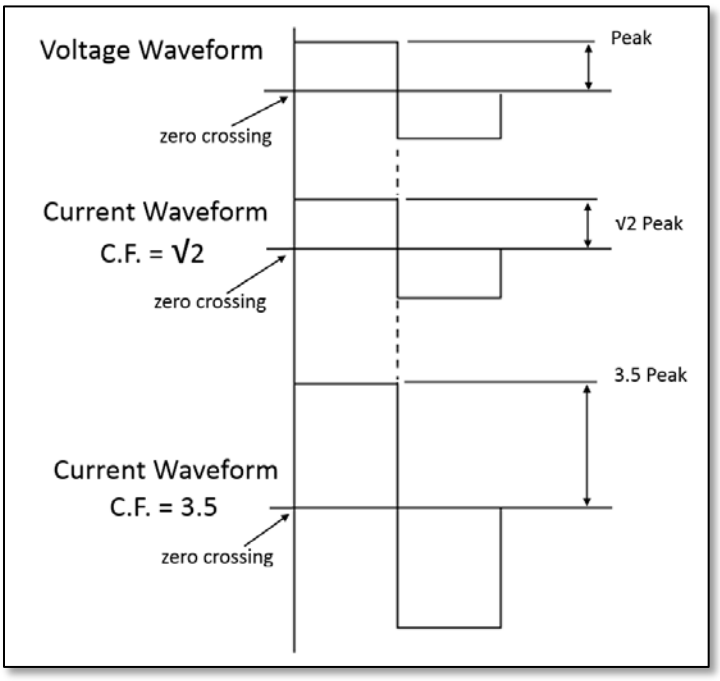



*Figure 6-7: DC Waveforms Bank 10*

### 6.5.3 Synchronization Source Setting

Synchronization of load current with AC input voltage is accomplished in one of two available SYNC modes:

- EXTERNAL SYNC
- INTERNAL SYNC

In **EXTERNAL SYNC** mode, the user must provide an input SYNC signal to the Ext. Sync. Input BNC terminal of the back panel of the load chassis.

The load will synchronize the current waveform to be in phase with the external SYNC signal.

**Note:** The external SYNC input signal must have a duty cycle of 50%.

In **INTERNAL SYNC** mode, the internal SYNC signal is taken from the sensed input voltage using the loads internal zero crossing detection and isolation circuits.

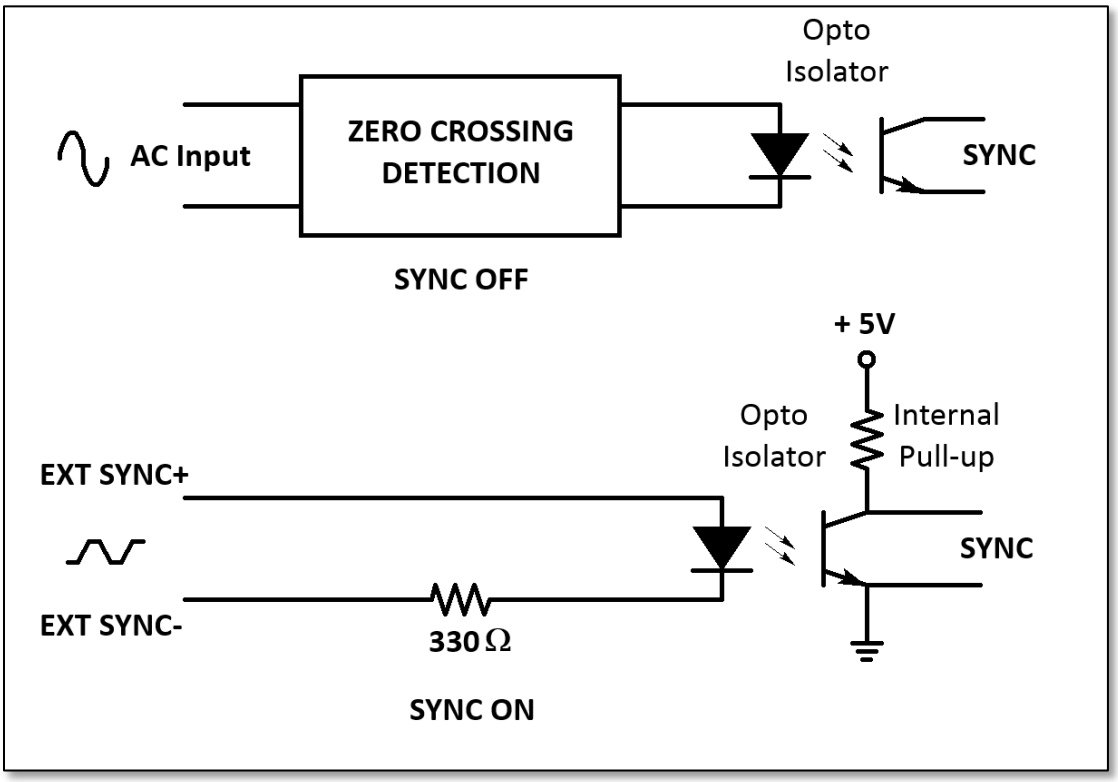



*Table 6-12: Internal or External Sync Circuits*

## 6.6 Initial Power-on Settings

### 6.6.1 Last Setting Recall

All 3B Series loads provide a 'last setup recall' feature. Using this feature, the 3B load can be set to return to the last setup state in effect at power off. This occurs the next time the load is turned back on and immediately following its power-on self-test. So rather than returning to the factory default setting shown in the tables above, it will return to the last state in which it was used.

### 6.6.2 Setup Memory Reset

If for any reason the non-volatile setup memory has been corrupted, it can be cleared and returned to factory defaults **(RESET)** using by pressing the "SENSE" and "PRES" keys on the front panel of the load simultaneously. During this RESET procedure, the display will show the load model number and firmware revision repeatedly and reset all settings to the factory defaults shown in the tables above until the keys are released.

### 6.6.3 Factory Default Initial Settings

When powering up the 3B Series electronic loads, the initial load settings after power ON or after resetting setup memory are as shown in the tables below by model number.

#### 6.6.3.1 Model 3B012-12 Power-on Settings

| Setting | Initial Value | Setting | Initial Value |
|---|---|---|---|
| MODE | CC | C.F. | √2 |
| LOAD | OFF | FREQ | FREQ = 60.0 Hz |
| LEVEL | A | | BANK = 0 |
| SENSE | OFF | | SYNC = OFF |
| PRES | OFF | CC LEVEL A | 0.000 A |
| WATT | OFF | CC LEVEL B | 0.000 A |
| LIMIT | VLIMIT = 400.00V | LIN LEVEL A | 0.000 A |
| | ALIMIT = 20.00A | LIN LEVEL B | 0.000 A |
| | WLIMIT = 2000.0W | CR LEVEL A | 80 kΩ |
| | VALIMIT = 2000.0W | CR LEVEL B | 80 kΩ |

*Table 6-13: Model 3B012-12 Power-on Settings*

#### 6.6.3.2 Model 3B018-18 Initial Settings

| Setting | Initial Value | Setting | Initial Value |
|---|---|---|---|
| MODE | CC | C.F. | √2 |
| LOAD | OFF | FREQ | FREQ = 60.0 Hz |
| LEVEL | A | | BANK = 0 |
| SENSE | OFF | | SYNC = OFF |
| PRES | OFF | CC LEVEL A | 0.000 A |
| WATT | OFF | CC LEVEL B | 0.000 A |
| LIMIT | VLIMIT = 400.00V | LIN LEVEL A | 0.000 A |
| | ALIMIT = 20.00A | LIN LEVEL B | 0.000 A |
| | WLIMIT = 2000.0W | CR LEVEL A | 53 kΩ |
| | VALIMIT = 2000.0W | CR LEVEL B | 53 kΩ |

*Table 6-14: Model 3B018-18 Power-on Settings*

#### 6.6.3.3 Model 3B024-24 Initial Settings

| Setting | Initial Value | Setting | Initial Value |
|---|---|---|---|
| MODE | CC | C.F. | √2 |
| LOAD | OFF | FREQ | FREQ = 60.0 Hz |
| LEVEL | A | | BANK = 0 |
| SENSE | OFF | | SYNC = OFF |
| PRES | OFF | CC LEVEL A | 0.000 A |
| WATT | OFF | CC LEVEL B | 0.000 A |
| LIMIT | VLIMIT = 400.00V | LIN LEVEL A | 0.000 A |
| | ALIMIT = 40.00A | LIN LEVEL B | 0.000 A |
| | WLIMIT = 4000.0W | CR LEVEL A | 40 kΩ |
| | VALIMIT = 4000.0W | CR LEVEL B | 40 kΩ |

*Table 6-15: Model 3A024-24 Power-on Settings*

#### 6.6.3.1 Model 3B036-36 Initial Settings

| Setting | Initial Value | Setting | Initial Value |
|---|---|---|---|
| MODE | CC | C.F. | √2 |
| LOAD | OFF | FREQ | FREQ = 60.0 Hz |
| LEVEL | A | | BANK = 0 |
| SENSE | OFF | | SYNC = OFF |
| PRES | OFF | CC LEVEL A | 0.000 A |
| WATT | OFF | CC LEVEL B | 0.000 A |
| LIMIT | VLIMIT = 400.00V | LIN LEVEL A | 0.000 A |
| | ALIMIT = 40.00A | LIN LEVEL B | 0.000 A |
| | WLIMIT = 4000.0W | CR LEVEL A | 26 kΩ |
| | VALIMIT = 4000.0W | CR LEVEL B | 26 kΩ |

*Table 6-16: Model 3B036-36 Power-on Settings*

#### 6.6.3.2 Model 3B054-54 Initial Settings

| Setting | Initial Value | Setting | Initial Value |
|---|---|---|---|
| MODE | CC | C.F. | √2 |
| LOAD | OFF | FREQ | FREQ = 60.0 Hz |
| LEVEL | A | | BANK = 0 |
| SENSE | OFF | | SYNC = OFF |
| PRES | OFF | CC LEVEL A | 0.000 A |
| WATT | OFF | CC LEVEL B | 0.000 A |
| LIMIT | VLIMIT = 400.00V | LIN LEVEL A | 0.000 A |
| | ALIMIT = 60.00A | LIN LEVEL B | 0.000 A |
| | WLIMIT = 6000.0W | CR LEVEL A | 17.776 kΩ |
| | VALIMIT = 6000.0W | CR LEVEL B | 17.776 kΩ |

*Table 6-17: Model 3B054-54 Power-on Settings*

#### 6.6.3.3 Model 3B072-72 Initial Settings

| Setting | Initial Value | Setting | Initial Value |
|---|---|---|---|
| MODE | CC | C.F. | √2 |
| LOAD | OFF | FREQ | FREQ = 60.0 Hz |
| LEVEL | A | | BANK = 0 |
| SENSE | OFF | | SYNC = OFF |
| PRES | OFF | CC LEVEL A | 0.000 A |
| WATT | OFF | CC LEVEL B | 0.000 A |
| LIMIT | VLIMIT = 400.00V | LIN LEVEL A | 0.000 A |
| | ALIMIT = 80.00A | LIN LEVEL B | 0.000 A |
| | WLIMIT = 8000.0W | CR LEVEL A | 13.333 kΩ |
| | VALIMIT = 8000.0W | CR LEVEL B | 13.333 kΩ |

*Table 6-18: Model 3B072-72 Power-on Settings*

#### 6.6.3.4 Model 3B090-90 Initial Settings

| Setting | Initial Value | Setting | Initial Value |
|---|---|---|---|
| MODE | CC | C.F. | √2 |
| LOAD | OFF | FREQ | FREQ = 60.0 Hz |
| LEVEL | A | | BANK = 0 |
| SENSE | OFF | | SYNC = OFF |
| PRES | OFF | CC LEVEL A | 0.000 A |
| WATT | OFF | CC LEVEL B | 0.000 A |
| LIMIT | VLIMIT = 400.00V | LIN LEVEL A | 0.000 A |
| | ALIMIT = 100.00A | LIN LEVEL B | 0.000 A |
| | WLIMIT = 10000.0W | CR LEVEL A | 10.666 kΩ |
| | VALIMIT = 10000.0W | CR LEVEL B | 10.666 kΩ |

*Table 6-19: Model 3B090-90 Power-on Settings*

#### 6.6.3.5 Model 3B108-108 Initial Settings

| Setting | Initial Value | Setting | Initial Value |
|---|---|---|---|
| MODE | CC | C.F. | √2 |
| LOAD | OFF | FREQ | FREQ = 60.0 Hz |
| LEVEL | A | | BANK = 0 |
| SENSE | OFF | | SYNC = OFF |
| PRES | OFF | CC LEVEL A | 0.000 A |
| WATT | OFF | CC LEVEL B | 0.000 A |
| LIMIT | VLIMIT = 400.00V | LIN LEVEL A | 0.000 A |
| | ALIMIT = 120.00A | LIN LEVEL B | 0.000 A |
| | WLIMIT = 12000.0W | CR LEVEL A | 8.888 kΩ |
| | VALIMIT = 12000.0W | CR LEVEL B | 8.888 kΩ |

*Table 6-20: Model 3B108-108 Power-on Settings*

#### 6.6.3.6 Model 3B126-126 Initial Settings

| Setting | Initial Value | Setting | Initial Value |
|---|---|---|---|
| MODE | CC | C.F. | √2 |
| LOAD | OFF | FREQ | FREQ = 60.0 Hz |
| LEVEL | A | | BANK = 0 |
| SENSE | OFF | | SYNC = OFF |
| PRES | OFF | CC LEVEL A | 0.000 A |
| WATT | OFF | CC LEVEL B | 0.000 A |
| LIMIT | VLIMIT = 400.00V | LIN LEVEL A | 0.000 A |
| | ALIMIT = 140.00A | LIN LEVEL B | 0.000 A |
| | WLIMIT = 14000.0W | CR LEVEL A | 7.616 kΩ |
| | VALIMIT = 14000.0W | CR LEVEL B | 7.616 kΩ |

*Table 6-21: Model 3B126-126 Power-on Settings*

## 6.7 Protection Features

The 3B Series electronic loads include the following protection features:

- Over Voltage
- Over Current
- Over Power
- Over Temperature

If any of these conditions occur, the load will turn off to protect it from any damage resulting from abnormal use. The protection status is indicated by a flashing display to notify the operator of a protection fault.

Actual trip limits for the various protection modes by model can be found in Section 4.3, “Protection Modes” of this manual.

### 6.7.1 Over Voltage Protection

The over voltage protection circuit is set at a predetermined voltage, which **cannot** be changed. If the over voltage circuit has tripped, the load input turns OFF immediately to prevent damaging the load. When an over voltage trip condition has occurred, the upper display will indicate "oVP" and flash on and off. Once the over voltage condition disappears, the upper display monitor will revert to normal operation.

### 6.7.2 Over Current Protection

The load always monitors the current it is sinking. When the current sink is greater than 105% of the rated maximum current, the load will change to the OFF state internally. When an over current condition has occurred, the upper display will indicate "oCP" and flash on and off. Once the over current condition disappears, the upper display monitor will revert to normal operation.

### 6.7.3 Over Power Protection

The load always monitors the power dissipated by the load. When the power dissipation is greater than 105% of the rated power input, the load will change to the OFF state internally. When an over power condition has occurred, the lower display will indicate "oPP" and flash on and off. Once the over power condition disappears, the lower display monitor will revert to normal operation.

### 6.7.4 Over Temperature Protection

As soon as the temperature of load’s internal heat sinks reaches a level greater than 85° C (180° F), the over temperature protection is triggered. The lower display will indicate "oTP" and flash on and off. Once the over temperature condition disappears, the lower display monitor will revert to normal operation.

Please check environmental conditions such as the ambient temperature and distance between the rear panel of the load chassis and any wall is greater than 15cm / 6 inches.

## 6.8 Load ON Voltage Adjustment

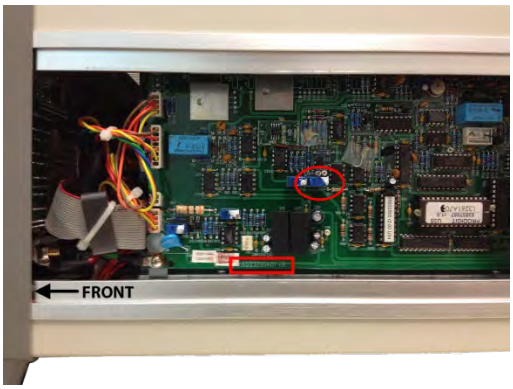
The factory default "Load ON" voltage is 2.0 volt. This means the 3B Series load starts to sink current from the connected EUT power supply until the input voltage exceeds the “Load ON” voltage threshold.

The "Load ON" voltage threshold can be adjusted between 2.0V and 20.0V. This threshold is set by a trim potentiometer (VR4) on the first PCB on the right hand side of the load. (P/N 6523261A01)

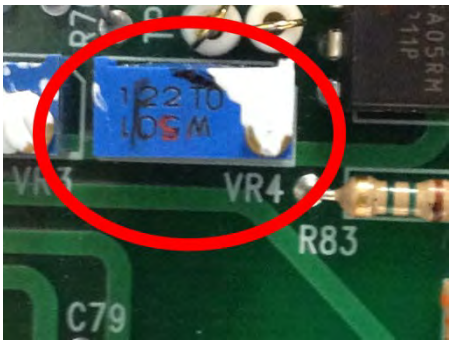
**The procedure to change the “Load ON” voltage setting should be undertaking only by qualified personnel.** If you are not experienced working with electronic assemblies, please seek assistance from someone who is.

*Remove 1 screw on rear panel*


*Slide outside cover panel to rear.*




*Locate adjustment pot VR4*




*Adjust per instructions.*

To adjust the “Load ON” setting, refer to the image shown here and proceed as follows:

1. Turn the load mainframe chassis off at the front panel Power On/Off switch.
2. Remove the load’s right-hand side aluminum cover panel by loosening the relevant screw on the rear panel.
3. The “Load ON” voltage setting trimmer is located on the first PCB (P/N: 6523261A01 ) once you remove the side cover of 3B Series load.
4. The load ON voltage setting trimmer VR4 can be adjusted here while power to the chassis is turned ON.
5. Turn the 3B load chassis back on.

6. Use a trim-pot driver to set VR4 to the most counter clockwise position. (Maximum load ON voltage).
7. Connect an AC power source (50Hz or 60Hz) to the AC Load input of the load.
8. Adjust the AC output voltage from the AC source to the required Load ON voltage. The voltage of AC power source should be less than the maximum rating of the “Load ON” voltage.
9. Set the Load ON/OFF key to ON state. The "load" LED annunciator should be lit on the front panel.
10. Set the load current to 1.0 Amp by using the PRES key. Press the PRES key again to turn the Preset mode OFF after the load current is set.
11. Make sure FREQ is set to50Hz or 60Hz to match the AC source setting.
12. Adjust the load ON voltage setting trimmer VR4 clockwise very slowly and stop immediately once the load starts to sink current from the AC power source. The LOAD ON voltage setting is finished in this procedure.
13. Replace to side panel when done.

# 7 Connectors

This section describes the various connectors available on the 3B Series AC & DC load.

## 7.1 INPUT Terminals

**Note:** Always refer to Section 2.3 “Safety Information” and Section 2.4 “Safety Notices” before making any load connections.

The positive (high) and negative (low) terminals for load input connections are located on the front panel. The Input terminal type connectors used on the 3B Series loads offer several convenient alternatives to making load connections. Specifically, the following five methods may be used:

### 7.1.1 Banana Jack Connectors

This is the most common way for connecting the equipment to be measured with 3B Series load. It is recommended that this connector be used when the load current is less than 20A as the maximum rated current of the plug connector is 20A. Please avoid exceeding maximum rated current to prevent damage caused by overheating. The maximum supported wire gauge for this connection method is AWG #14.

### 7.1.2 Spade Lug Terminals

Included in the 3B Series load ship kit is a set of two (2) spade lug-type terminals. These can be used to crimp on to stripped wire ends of an EUT. Hook-type terminals provide good contacting characteristics. It is recommended that the hook-type terminal be used for any occasion where practical. The maximum supported wire gauge of the connection wires for this connection method is AWG #10.

### 7.1.3 Lead Wire Insertion

This is the simplest way to insert stripped ends of connecting wires into the holes on the metal portion of the input connector jacks. The maximum supported gauge of the connecting wire for this connection method is AWG #14.

### 7.1.4 Banana Jack Connector and Spade Lug Terminals

This combination method provides a higher current rating and lower impedance of the load connection. When input load currents are higher than 20A or the connecting lead wire is long, this method will be optimal.

### 7.1.5 Plug Connector and Lead Wire Insertion

This method can also be used when the input current is higher than 20A or the connecting lead wire is longer.

## 7.2 Wire Size

A major consideration in making input connection is the wire size. The minimum wire size is required to prevent overheating and to maintain good regulation. It is recommended that the wires are sized large enough to limit the voltage drop at the maximum current rating of the AC & DC load to less than 0.5V per connection lead.

## 7.3 Connecting a UUT

**WARNING**

**DO NOT EXCEED LOAD INPUT VOLTAGE RATING**

**This instrument does NOT have a means to disconnect its Load input from a connected power supply. If the voltage applied to the Load input exceeds its maximum rating – even if the load is turned completely off – damage to the load WILL occur. Damage caused by exceeded maximum load input voltage under any circumstance is NOT covered by the manufacturer's product warranty. Remove any load input connections when the load is not in use, even when it is turned off.**

When setting up for a new test and connecting any equipment to the AC & DC load, proceed as follows:

1. Always make sure the AC & DC load is turned OFF at the POWER switch when making any wire connections.
2. Check that the output of the equipment under test is **OFF**.
   **Note:** Some power equipment's output may still be energized even if the equipment has been turned off or its output is turned off. This is especially true for DC power supplies.

   Note: When working with batteries, it is recommended to provide a suitable disconnect relay or switch so the load connection can be disconnected from the battery for handling purposes.
3. Connect one end of the load wires to the load input terminals on the rear panel.
4. Check the polarity of the connections and connect the other end of the load wires to the output terminal of the equipment under test.
5. When connecting multiple loads to the same EUT, makes sure the load wire lengths to each load are the same.

## 7.4 Voltage Sense Input Terminals

To measure the UUT output voltage at the EUT terminals rather than the load input terminals, the external voltage sense mode must be used. The external voltage sense wire harness is provided for this purpose. It connects to the Voltage sense connector on the front panel of the load.

For small loads that deliver only low levels of current, INTERNAL sense can be used. For larger loads that draw a considerable amount of current, EXTERNAL sense mode will compensate for voltage drop along the load connection wires. Refer to Figure 7-1 below.

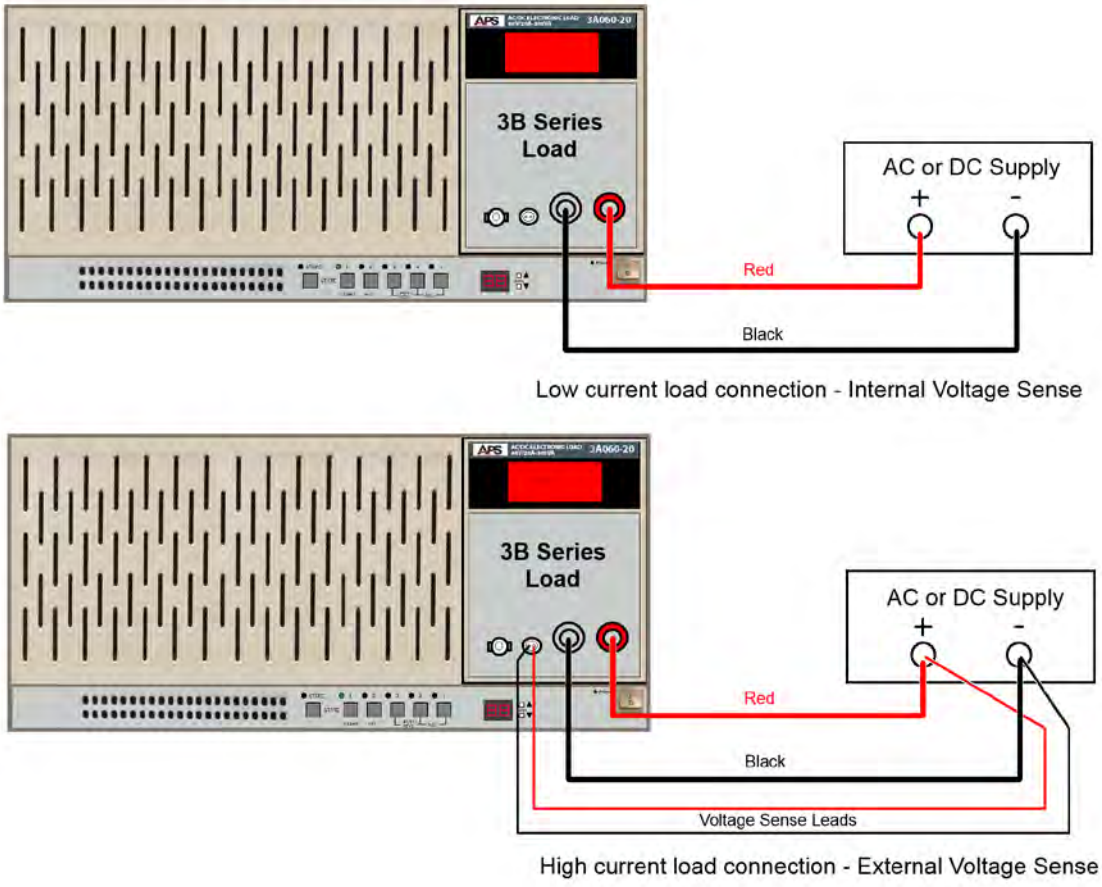



*Figure 7-1: Internal and External Voltage Sense Connections*

## 7.5 Current Output Monitor (I-Monitor)

The I-Monitor terminal is designed to monitor the electronic load's sink current. An isolated amplifier output with a 0 - 4Vrms / 0 – 10Vpp full scale output signal represents the zero to full scale current the electronic load is sinking. Regardless of Preset ON or OFF state, the analog signal output from the I-monitor is in direct proportion to the load current flowing through the load. Please refer to the I-Monitor voltage /current scaling values for each 3B Series load in Section 4, “Technical Specifications”.

### 7.5.1 Isolated Output

The insulation voltage rating between the AC input end of the 3B Series electronic load and the I-monitor BNC output end is 500V. Also, the reference potential at the negative end of BNC is the same as the GPIB connector earth potential of the load.

As the isolated insulation amplifier inside the load provides a convenient testing solution as it solves the problem of isolating voltage and current monitoring and eliminates the potential short circuit or ground loop issues that can occur when a single oscilloscope is used for monitoring both voltage and current.

Since most oscilloscope input channels BNC shields are chassis grounded, connecting two or more channels with different ground references normally requires additional isolation probes.

The I-monitor BNC output signal on 3B Series loads is through an isolation amplifier, e.g., the earth potential of the output analog signal and the earth potential of the load input are electrically isolated from each other. In this way, when a connection is made to an oscilloscope on which another input channel is connected to both the high and low side of the load to monitor voltage, no metering error results from any current flowing between the negative end of the I-monitor BNC output and the negative end of the oscilloscope due to any voltage differential.

**Note**: The EUT source low side will still be grounded by connecting it to an oscilloscope channel input so if the source under test low side is not ground referenced, the voltage monitor channel will require the use of an isolation probe.

# 8 Remote Control Programming

## 8.1 Overview

If your unit is fitted with a computer interface option then a GPIB and/or RS232 connector will be present on the rear panel based on the order configuration. The interface allows the load settings to be configured remotely and measurement data to be retrieved for analysis and test report generation.

There are two sets of programming commands for APS Loads. One is referred to as the SHORT FORM commands and the other set as the LONG FORM commands.

For Example

To query the actual voltage present at the load form the load's measurement system, the long form command is:

*MEASURE:VOLTAGE?*

The same command in its short form is:

*MEAS:VOLT?*

**NOTE:** When the RS232 interface is used to control the load, it is important to send the "REMOTE" command first to make sure the load is in REMOTE state. To return the load to local operation, the "LOCAL" command is used. These two commands do not apply to the GPIB interface as remote and local state of an instrument is handled through the GPIB ATN hardware signal per theIEEE488 standard.

## 8.2 RS232 Set-up

The RS232 interface of the APS 3B load is configured as follows:

| | |
|---|---|
| Baud-rate: | 9600 bps |
| Parity: | None |
| Data bit: | 8 bits |
| Stop bit: | 1 bit |
| Command delay: | 20 msecs between successive commands is required to allow command parsing and processing. |

Make sure the settings used on the controller's COM port match those of the load.

The RS232 interface connector DB9 pin-out of the load is shown in *Table 8-1*.

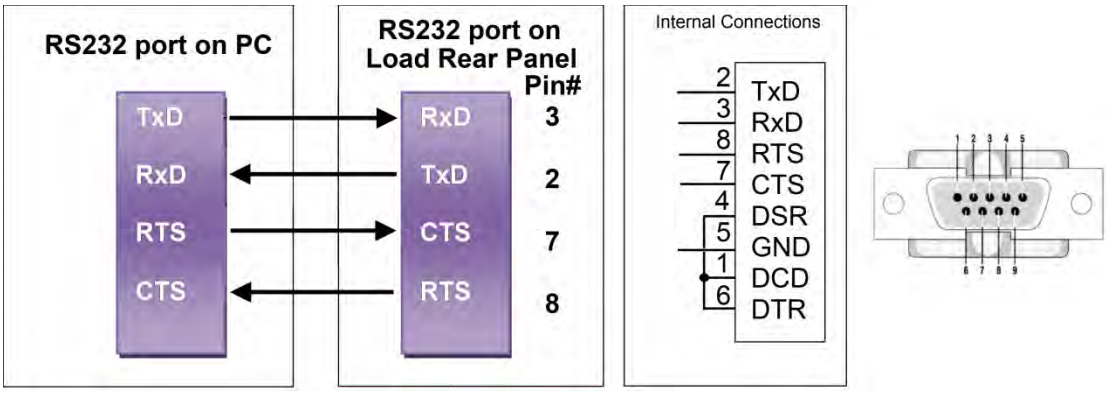



*Figure 8-1: RS232 Connection to PC and DB9 Pin out*

RS232 DB9 Signal Pin Assignments:

| PIN | Abbreviation | Description |
|---|---|---|
| **Pin1** | Not used | |
| **Pin2** | TXD | Transmit Data |
| **Pin3** | RXD | Receive Data |
| **Pin4** | Not used | |
| **Pin5** | GND | Ground |
| **Pin6** | Not used | |
| **Pin7** | CTS | Clear to Send |
| **Pin8** | RTS | Request to Send |
| **Pin9** | Not used | |

*Table 8-1: RS232 DB9 Pin Assignments*

## 8.3 Programming Syntax

A variety of syntax notations are used in the description of the remote control commands and in the summary tables. The syntax used is defined as follows:

- SP Space, the ASCII code is 20 hexadecimal.
- ; Semicolon, program line terminator, the ASCII code is 0A hexadecimal.
- NL New line, program line terminator, the ASCII code is 0A hexadecimal.
- NR2 Numeric value with decimal point. Values can be accepted in the range and format of ###.#####. For example: 30.12345. In this instance, the load will read up to five significant digits after the decimal point. The decimal point can be omitted if not required.

### 8.3.1 Parenthesis

The following parentheses are used in the command descriptions to indicate whether a command is necessary or optional and whether a choice has to be made. The symbols { }, [ ], and | are not actually used in the programming commands. The symbols { }, [ ] and | are merely used to illustrate the command syntax.

{ } - Required: The contents of the { } symbol must be used as part of the command, it cannot be omitted.

[ ] - Optional: The contents of the [ ] symbol indicates that the command is optional. The use of the contents depends on the test application.

| - Required Choice: This symbol means a choice must be made between the stated command key words. For example, “LOW|HIGH” Means a LOW or HIGH choice needs to be made as part of the command.

? - Required Choice: The question mark implies the query format of the command.

### 8.3.2 Terminators

All remote control commands sent to the load must be terminated with a command terminator. The command terminator characters accepted by the APS loads are listed in *Table 8-2*.

| Terminator | Hex Code | Decimal | C Code | Notes |
|---|---|---|---|---|
| **LF** | 0x0A | 10 | \n | |
| **LF+ EOI** | 0x0A | 10 | \n | GPIB only |
| **CR+LF** | 0x0D + 0x0A | 13 + 10 | \r\n | |
| **CR+LF+EOI** | 0x0D + 0x0A | 13 + 10 | \r\n | GPIB only |

*Table 8-2: Supported Command Terminators*

Semicolon “;” The semicolon character allows you to combine multiple commands in one message string to create a command sequence. The commands will be parsed in the order in which they are received.

## 8.4 Command Syntax Tables

The setting and query commands for the loads are listed in the summary tables below. Short form commands use an abbreviated syntax, which reduces the amount of characters required for each command and thus increases throughput. They short form syntax is shown in upper case. The long from syntax is shown as lower case.

| SETTING PRESET COMMANDS | REMARK |
|---|---|
| [PRESet:] BANK{SP}{d}{;\|NL} | d = 0 through 10 |
| [PRESet:] BANK{SP}{?}{;\|NL} | d = 0 through 10 |
| [PRESet:] WAVE{SP}{m}{;\|NL } | m = 0 through 4 |
| [PRESet:] WAVE{SP}{?}{;\|NL} | m = 0 through 4 |
| [PRESet:] FREQuency{SP}{NR2}{;\|NL} | 0.1 through 400.0Hz |
| [PRESet:] FREQuency{?}{;\|NL} | 0.1 through 400.0Hz |
| [PRESet:] CC: \| CURRent:{A\|B}{SP}{NR2}{;\|NL} | |
| (PRESet:] CC: \| CURRent: {A\|B}{?}{;\|NL} | ###.#### |
| [PRESet:] CR: \| RES: {A\|B}{SP}{NR2}{;\|NL} | |
| [PRESet:] CR: \| RES: {A\|B}{?}{;\|NL} | ###.#### |
| [PRESet:] LIN:{A\|B}{SP}{NR2}{;\|NL} | |
| [PRESet:] LIN:{A\|B}{?}{;\|NL} | ###.#### |

*Table 8-3: Setting Commands - Short Form*

| LIMIT COMMANDS | REMARK |
|---|---|
| LIMit:CURRent:{HIGH\|LOW}{SP}{NR2}{;\|NL} | |
| LIMit:CURRent:{HIGH\|LOW}{?}{;\|NL} | ###.#### |
| LIMit:POWer:{HIGH\|LOW}{SP}{NR2}{;\|NL} | |
| LIMit:POWer:{HIGH\|LOW}{?}{;\|NL} | ###.#### |
| LIMit:VA:{HIGH\|LOW}{SP}{NR2}{;\|NL} | |
| LIMit:VA:{HIGH\|LOW}{?}{;\|NL} | ###.#### |
| LIMit:VOLTage:{HIGH\|LOW}{SP}{NR2}{;\|NL} | |
| LIMit:VOLTage:{HIGH\|LOW}{?}{;\|NL} | ###.#### |

*Table 8-4: Limit Commands - Short Form*

| STATE COMMANDS | REMARK |
|---|---|
| [STATe:] ERRor? {;\|NL} | ERROR CODE |
| [STATe:] LOAD{SP}{ON\|1 \| 0 \| OFF}{;\|NL} | |
| [STATe:] LOAD{?}{;\|NL} | 0:OFF, 1:ON |
| [STATe:] MODE{SP}{CC \| 0 \| CR \| 1 \| LIN \| 2}{;\|NL} | |
| [STATe:] MODE{?}{;\|NL} | 0:CC, 1:CR, 2: LIN |
| [STATe:] PRESet{?}{;\|NL} | 0:OFF, 1:ON |
| [STATe:] SENSe{SP}{ON\|OFF}{;\|NL} | |
| [STATe:] LEVel{SP}{HIGH\|LOW\|A\|B} {;\|NL} | |
| [STATe:] LEVel{?}{;\|NL} | 0:LOW, 1:HIGH |
| [STATe:] SYNCronize{SP}{ON \| 1 \| OFF \| 0}{;\|NL} | |
| [STATe:] SYNCronize{?}{;\|NL} | 0:OFF, 1:ON |
| [STATe:] WATT{SP}{ON \| 1 \| OFF \| 0}{;\|NL} | |
| [STATe:] WATT{?}{;\|NL} | 0:OFF, 1:ON |
| [STATe:] NG{?}{;\|NL} | 0:OK, 1:NG |
| [STATe:] PROTect{?}{;\|NL} | DDDDDDDD |

*Table 8-5: State Commands - Short Form*

| SYSTEM COMMANDS | NOTES | REMARKS |
|---|---|---|
| [SYSTem:] RECall{SP}{M[,N]}{;\|NL} | M=1~5 N=1~30 | |
| [SYSTem:] STORe{SP}{M[,N]}{;\|NL} | M=1~5 N=1~30 | |
| [SYSTem:] REMote{;\|NL} | RS232 only | |
| [SYSTem:] LOCal{;\|NL} | RS232 only | 0:OFF, 1:ON |
| [SYSTem:] NAME{?}{;\|NL} | | "XXXXX" |

*Table 8-6: System Commands - Short Form*

| MEASUREMENT QUERY COMMANDS | REMARKS |
|---|---|
| MEASure:CURRent {?}{;\|NL} | ###.#### |
| MEASure:VOLTage {?}{;\|NL} | ###.#### |
| MEASure:POWer {?}{;\|NL} | ###.#### |
| MEASure:VA {?}{;\|NL} | ###.#### |

*Table 8-7: Measurement Query Commands - Short Form*

### 8.4.1 Notations and Conventions Used in programming commands:

1. Current engineering unit: A
2. Voltage engineering unit: V
3. Resistance engineering unit: Ω
4. Frequency engineering unit: Hz
5. Time Period engineering unit: ms
6. Slew-rate engineering unit: A/us
7. Power engineering unit: W

## 8.5 Remote Control Command Descriptions

The remote control syntax of all available commands is described in the following sections. Supported commands are grouped in the following categories:

| Command Category | Description |
|---|---|
| **SETTING (PRESET)** | Setting commands are used to program operating modes, sink values and built in test modes like SHORT, OPP and OCP. |
| **LIMIT** | Limit commands may be used to set expected upper and lower operating limits as they apply to a unit under test. These limit settings are used in conjunction with Go/NG testing to indicate the load is sinking outside expected parameters. |
| **STATE** | State commands are used to query or clear status information from a load to determine its operating condition. |
| **SYSTEM** | System commands enable querying of load model number and configuration data, RS232 control on/off. They also support storing and saving load set-ups in non-volatile memory. (15 Banks / 10 States) |
| **MEASUREMENTS** | Allows querying load measurement data. |
| **IEEE488.2 COMMANDS** | Supported IEEE488.2 Commands ( a.k.a. star commands) |

### 8.5.1 SETTING Commands

BANK

**Command Syntax:**

[PRESet:] BANK{SP}{d}{;|NL}

[PRESet:] BANK{SP}{?}{;|NL}Purpose:

**Purpose:** Set or read the waveform bank number. Bank number 'd' ranges from 0 through 10. Refer to *Table 8-8* for bank and waveform locations.

**Description:** This command is used to set or query the waveform bank number.

1. The least significant number is the fifth digit after the decimal point.
2. Should a value be entered that is higher than what is possible then the load will automatically set the maximum value according the load model.

WAVEform

**Command Syntax:**

[PRESet:] WAVE {SP} {m} {;|NL }

[PRESet:] WAVE {SP} {?} {;|NL }

**Purpose:** Set or read the waveform number for the desired current crest factor in the selected bank. Waveform number 'm' ranges from 0 through 4. Refer to *Table 8-8* for bank and waveform locations.

**Description:** This command is used to set or query the waveform number.

1. The least significant number is the fifth digit after the decimal point.
2. Should a value be entered that is higher than what is possible then the load will automatically set the maximum value according the load model.

| Waveform | BANK | WAVE = 0 | WAVE = 1 | WAVE = 2 | WAVE = 3 | WAVE = 4 | Phase Shift |
|---|---|---|---|---|---|---|---|
| **Sine wave** | 0 | √2 | 2.0 | 2.5 | 3.0 | 3.5 | |
| | 1 | 1.5 | 1.6 | 1.7 | 1.8 | 1.9 | |
| | 2 | 3.0 | 3.1 | 3.2 | 3.3 | 3.4 | |
| **C.F. = 2** | 3 | P.F. = -0.85 | P.F. = -0.80 | P.F. = -0.75 | P.F. = -0.70 | P.F. = -0.65 | Lagging PF |
| **C.F. = 2.5** | 4 | P.F. = -0.75 | P.F. = -0.70 | P.F. = -0.65 | P.F. = -0.50 | P.F. = -0.40 | |
| **C.F. = 3.5** | 5 | P.F. = -0.50 | P.F. = -0.45 | P.F. = -0.40 | P.F. = -0.35 | P.F. = -0.30 | |
| **C.F. = 2** | 6 | P.F. = +0.85 | P.F. = +0.80 | P.F. = +0.75 | P.F. = +0.70 | P.F. = +0.65 | Leading PF |
| **C.F. = 2.5** | 7 | P.F. = +0.75 | P.F. = +0.70 | P.F. = +0.65 | P.F. = +0.50 | P.F. = +0.40 | |
| **C.F. = 3.5** | 8 | P.F. = +0.50 | P.F. = +0.45 | P.F. = +0.40 | P.F. = +0.35 | P.F. = +0.30 | |
| **Square** | 9 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | |
| **DC** | 10 | √2 dc | 2 dc | 2.5 dc | 3.0 dc | 3.5 dc | |

*Table 8-8: AC CC Mode BANK and WAVE Table*

[PRESet:] FREQuency {SP} {NR2} {;|NL}

**Command Syntax:**

[PRESet:] FREQuency {SP} {NR2} {;|NL}

[PRESet:] FREQuency {?} {;|NL}

**Purpose:** Set or read the expected AC frequency at the load input.

**Description:** This command is used to set or query the frequency setting.

1. The least significant number is the fifth digit after the decimal point.
2. Should a value be entered that is higher than what is possible then the load will automatically set the maximum value according the load model.
3. Valid frequency range for 3B series load is DC or 0.1 Hz through 400.0 Hz
4. The engineering unit is Hz.

CURRent

**Command Syntax:**

[PRESet:] CC | CURR {A | B} {NR2} {: | NL}

[PRESet:] CC | CURR {A | B} {?} {; | NL}

**Purpose:** Set or read the load current for level A or B.

**Description:** This command is used to set or query the load current. There are two set points, A and B. This allows the user to switch between two current levels.

1. The least significant number is the fifth digit after the decimal point.
2. Should a value be entered that is higher than what is possible then the load will automatically set the maximum value according the load model.
3. The engineering unit is A.

CR | RES: {A | B}

**Command Syntax:**

[PRESet:] CR | RES:{A | B} {SP} {NR2} {; | NL}

[PRESet:] CR | RES:{A | B} {?} {; | NL}

**Purpose:** Set and read the A or B resistance levels.

**Description:** This command is used to set or query the A and B levels of load resistance. There are two set points, A and B. This allows the user to switch between two resistance levels.

1. The least significant number is the fifth digit after the decimal point.
2. The A level resistance value cannot be higher than the B level.
3. Should a value be entered that is higher than what is possible then the load will automatically set its maximum value according the load model.
4. The engineering unit is Ω.

LINear

**Command Syntax:**

[PRESet:] LIN: {A | B} {SP} {NR2} {;|NL}

[PRESet:] LIN: {A | B} {?} {;|NL}

**Purpose:**

Set and read the A or B current levels.

**Description:**

This command is used to set or query the A and B levels of current in linear mode. There are two set points, A and B. This allows the user to switch between two current levels.

1. The least significant number is the fifth digit after the decimal point.
2. The A level current value cannot be higher than the B level.
3. Should a value be entered that is higher than what is possible then the load will automatically set its maximum value according the load model.
4. The engineering unit is A.

### 8.5.2 LIMIT Commands

LIMIT commands are used to set high and low operating limits that can be used in conjunction with the Go/NoGo (NG) function to signal that the load is sinking outside the expected parameters.

[LIMit:]CURRent:{HIGH | LOW}

**Command Syntax:**

[LIMit:]CURRent:{HIGH | LOW} {SP} { NR2 } {;|NL}

[LIMit:]CURRent:{HIGH | LOW}? {;|NL}

**Purpose:** Set or query the HIGH / LOW load current limits when operating in CC or CR modes.

**Description:** This command is used to set or query two current LIMIT values. Operation outside these LIMIT values will cause a No Good (NG) signal to be generated.

1. The LOW level cannot be higher than the HIGH level.
2. If the current taken by the load falls below the LOW limit then a No Good (NG) signal is available.
3. If the current rises above the HIGH limit then the NG signal is available.
4. If the current stays between HIGH and LOW LIMIT levels the NG signal will not be set.

[LIMit:]POWer:{HIGH | LOW}

**Command Syntax:**

[LIMit:]POWer:{HIGH | LOW}{SP}{ NR2 }{;|NL}

[LIMit:]POWer:{HIGH | LOW}? {;|NL}

**Purpose:** Set or query the HIGH / LOW load power limits when operating in CC or CR modes.

**Description:** This command is used to set two power LIMIT values. Operation outside these LIMIT values will cause a NG signal to be generated.

1. The LOW level cannot be higher than the HIGH level.
2. If the power taken by the load falls below the LOW limit then a No Good (NG) signal is available.
3. If the power rises above the HIGH limit then the NG signal is available.
4. If the power stays between HIGH and LOW LIMIT levels the NG signal will not be set.

[LIMit:]VA:{HIGH | LOW}

**Command Syntax:**

[LIMit:]VA:{HIGH | LOW}{SP}{ NR2 }{;|NL}

[LIMit:]VA:{HIGH | LOW}? {;|NL}

**Purpose:** Set or query the HIGH / LOW load apparent power limits when operating in CC or CR modes.

**Description:** This command is used to set two apparent power LIMIT values. Operation outside these LIMIT values will cause a NG signal to be generated.

1. The LOW level cannot be higher than the HIGH level.
2. If the apparent power taken by the load falls below the LOW limit then a No Good (NG) signal is available.
3. If the apparent power rises above the HIGH limit then the NG signal is available.
4. If the apparent power stays between HIGH and LOW LIMIT levels the NG signal will not be set.

[LIMit:]VOLtage:{HIGH | LOW}

**Command Syntax:**

[LIMit:]VOLtage:{HIGH | LOW} {SP} { NR2 }{;|NL}

[LIMit:]VOLtage:{ HIGH | LOW}? {;|NL}

**Purpose:** Set or query the HIGH / LOW limits for the voltage present at the load terminals.

**Description:** This command is used to set two voltage LIMIT values. Operation outside these LIMIT values will cause a NG signal to be generated.

1. The LOW level cannot be higher than the HIGH level.
2. If the voltage at the load input falls below the LOW limit then a No Good (NG) signal is available.
3. If the voltage rises above the HIGH limit then the NG signal is available.
4. If the current stays between HIGH and LOW LIMIT levels, the NG signal will not be set.

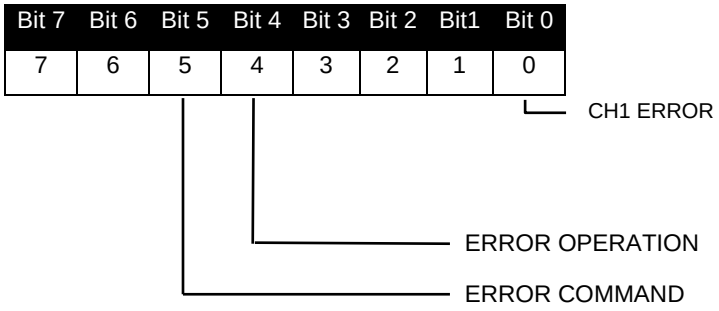
### 8.5.3 STATE Commands

STATE commands can be used to set or query the actual operating status of the electronic load at any time.

[STATe:] ERRor

**Command Syntax:**
[STATe:] ERRor? {; | NL}
**Purpose:**
Query if there are any errors flagged set. Also clears error register.
**NOTE:** Comparable to IEEEE488.2 *ESR? Command but return values used different bit assignments.
**Description:**

1. ERR? : Read the register of ERR status. Table below shows the corresponding number of ERR status bits returned.
2. Use command CLR to clear the register of ERR status to be"0"




| BIT ID | BIT VALUE | REMARK |
|---|---|---|
| bit 0-3 | 0 = Off, 1 = Triggered | CH1 error |
| bit 4 | 0 = Off, 1 = Triggered | Operation error |
| bit 5 | 0 = Off, 1 = Triggered | Command error (e.g. syntax error) |

*Table 8-9: Error Register*

[STATe:] LOAD {SP} {ON | 1 | OFF | 0}

**Command Syntax:**

[STATe:] LOAD {SP} { ON | 1 |OFF | 0}{; | NL}

[STATe:] LOAD? {; | NL}

**Purpose:** Turns load on or off. Query format returns LOAD ON or OFF status.

**Description:** This command is used to turn the load on or off.

**Query response:** 0 = OFF, 1 = ON.

[STATe:] MODE {SP} {CC | 0 | CR | 1 | LIN | 2}

**Command Syntax:**

[STATe:] MODE {SP} { CC | 0 | CR | 1 | LIN | 2}

[STATe:] MODE? {; | NL}

**Purpose:** Set and read the operating mode of LOAD.

**Description:** The return value is 0 | 1 | 2 which corresponds to the operating mode that the load is in. i.e. CC | CR | LIN.

**Query response:** See table below

| Mode: | CC | CR | LIN |
|---|---|---|---|
| Value: | (0) | (1) | (2) |
| Supported | √ | √ | √ |

[STATe:] PRESet {SP} { ON | 1 |OFF | 0}

**Command Syntax:**

[STATe:] PRESet {SP} {ON | 1 | OFF | 0}{; | NL}

[STATe:] PRESet? {; | NL}

**Purpose:** Turns load on or off. Query format returns preset mode state.

**Description:** This command is used to check if the load is in preset mode.
0 = Preset mode OFF, 1 = Preset mode ON

**Query response:** 0 = OFF, 1 = ON.

[STATe:] SENSe{SP} {ON | 1 | OFF | 0}

**Command Syntax:**

[STATe:] SENSe {SP}{ON | 1 | OFF | 0}{; | NL}

[STATe:] SENSe? {; | NL}

**Purpose:** Sets or reads back whether the voltage sense function is ON or OFF.

**Description:**

**Query response:** 0 = OFF, 1 = ON

[STATe:] LEVel {SP} {HIGH | LOW | A | B}

**Command Syntax:**

[STATe:] LEVel {SP} {HIGH | LOW | A | B} {; | NL}

[STATe:] LEVel? {; | NL}

**Purpose:** Sets or reads back whether the load is operating at its LOW or HIGH LEVEL.

**Description:** In CC, CR or LIN operating modes the user can set two LEVELS of load current, or resistance. The query format will return the active level.

**Query response:** 0 = LOW | A, 1 = HIGH | B

[STATe:] SYNCronize {SP} {ON | 1 |OFF | 0}{;|NL}

**Command Syntax:**

[STATe:] SYNCronize {SP} { ON | 1 |OFF | 0}{;|NL}

[STATe:] SYNCronize {?} {;|NL}

**Purpose:** Sets the internal or external sync mode. Query format return sync setting.

**Description:** This state determines if the load current is synchronized to:

1. The sensed voltage through the internal zero-crossing circuit and isolated circuit.
2. To the external sync input.

**Query response:** 0 = Internal Sync, 1 = External Sync.

[STATe:] WATT{SP} { ON | 1 |OFF | 0} {;|NL}

**Command Syntax:**

[STATe:] WATT{SP} { ON | 1 |OFF | 0} {;|NL}

[STATe:] WATT{?} {;|NL}

**Purpose:** This command sets the display of the power meter. This command has to be used in conjunction with the PRES：OFF command.

**Description:** The front panel display read outs can be toggled between voltage and current readout or power and apparent readout using this command:

1. When set to OFF, the monitor on top of the display will display voltage while the bottom monitor will display current. Units are “Vrms” and ”Arms” respectively.
2. When set to ON, the monitor on top of the display will change from voltmeter to watt meter, while the monitor at the bottom of the display will change from ammeter to Volt-Ameter (VA). Units are “W” and ”VA” respectively.

**Query response:** 0 = V and I displayed, 1 = W and VA displayed

[STATe:] NG? {; | NL}

**Command Syntax:**

[STATe:] NG? {; | NL}

**Purpose:** Query if the NG annunciator is lit.

**Description:** This command queries the NG status. If the response is “0”, the NG (NO GOOD) annunciator on the load is off. If the response is ”1”, the NG annunciator on the load is lit, indicating that the NG flag is set.

**Query response:** 0 = OFF, 1 = ON

[STATe:] PROTect? {; | NL}

**Command Syntax:**

[STATe:] PROTect? {; | NL}

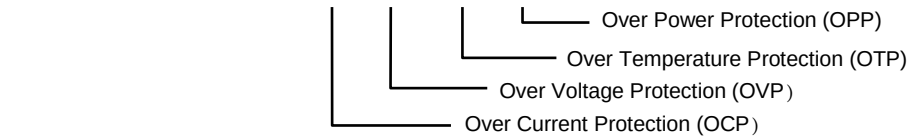
**Purpose:** Query the state of the protection register.

**Description:**

1. PROT? requests the status of the units protection register.
2. Use the command “CLR” to clear the register of PROT status to “0”.

**Query response:** 0 - 255

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |




| BIT ID | BIT VALUE | REMARK |
|---|---|---|
| **bit 0** | 0 = Off, 1 = Triggered | Over Power Protection (OPP) |
| **bit 1** | 0 = Off, 1 = Triggered | Over Temperature Protection (OTP) |
| **bit 2** | 0 = Off, 1 = Triggered | Over Voltage Protection (OVP) |
| **bit 3** | 0 = Off, 1 = Triggered | Over Current Protection (OCP) |

### 8.5.4 SYSTEM Commands

SYSTEM commands allow the user to read the model number of the load and turn RS232 remote control state ON and OFF. Commands are also available for storing and retrieving load set-ups saved in the memory of the load.

[SYStem:] RECall {SP} { m} [, n]

**Command Syntax:**

[SYStem:] RECall {SP} {m} [, n] {; | NL}

**Purpose:** Recalls a previously stored load set-up from memory. The load has 150 separate memory locations. This is comprised of 30 memory BANKS with each bank having 5 STATES.

| Type | Locations |
|---|---|
| **BANK (n)** | 30 |
| **STATE (m)** | 5 |
| **Total States / Mem. Locations** | 150 |

**Description:** This command is for recalling the procedure stored in a specified memory location where:

m = STATE, 1 through 5

n = BANK, 1 through 30

If the memory STATE to be used is from the currently selected BANK as shown on the mainframe's display, then the BANK [n] can be omitted.

**Example:**

RECALL 2,15 Recalls the load set up saved in the 2nd STATE and 15th BANK of the memory.

REC 3 Recalls the load set up from the 3rd memory STATE from the current BANK as shown on the units front panel display.

[SYStem:] STORe {SP} {m}[, n]

**Command Syntax:**

[SYStem:] STORe {SP} {m} [, n] {; | NL}

**Purpose:**

Saves the load's status to the unit's memory.

**Description:** This command is used to save the current set-up to a specified memory location where:

m = STATE, 1 through 10

n = BANK, 1 through 15

If the memory STATE to be saved to the currently selected BANK then the BANK [n] part of the command can be omitted.

**Example:**

| | |
|---|---|
| STORE 2, 15 | Saves the status of the load to the 2nd STATE of the 15th memory BANK. |
| STOR 3 | Saves the load setup to the 3rd memory STATE of the current BANK as shown on the units front panel display. |

[SYStem:] REMOTE

**Command Syntax:**

[SYStem:] REMOTE {: | NL}

**Purpose:** Command to enter REMOTE status (only for RS232).

**Description:** This command is for enabling control of the unit via RS232.

[SYStem:] LOCAL

**Command Syntax:**

[SYStem:] LOCAL {; | NL}

[SYStem:] LOCAL? {; | NL}

**Purpose:** Command to exit the REMOTE status (only for RS232). The query format will return remote or local status of the mainframe.

**Description:** This command closes the RS232 control interface.

**Query response:** 0 = LOCAL, 1 = REMOTE

[SYStem:] NAME?

**Command Syntax:**

[SYStem:] NAME? {; | NL}

**Purpose:** Returns the APS model number of the load.

**Description:** This command is for reading the model number of the selected load. If no load is present, the query will return "NULL". The model number will be returned as per *Table 8-10*.

**Query response:**

| APS-Model | Return Value |
|---|---|
| **3B012-12** | 3B012-12 |
| **3B024-24** | 3B024-24 |
| **3B018-18** | 3B018-18 |
| **3B036-36** | 3B036-36 |
| **3B054-54** | 3B054-54 |
| **3B072-72** | 3B072-72 |
| **3B090-90** | 3B090-90 |
| **3B108-108** | 3B108-108 |
| **3B126-126** | 3B126-126 |

*Table 8-10: 3B Series Load Model Name Return Values*

### 8.5.5 MEASUREMENT Commands

Measurement commands allow measurement data to be retrieved.

MEASure:CURRent?

**Command Syntax:**

MEASure:CURRent? {; | NL}

**Purpose:** Measures the load current.

**Description:** Reads the current meter data. The engineering unit is Ampere (A).

**Query response:** ###.#### (floating point, 4 decimal places)

MEASure:VOLtage?

**Command Syntax:**

MEASure:VOLtage? {; | NL}

**Purpose:** Measures the load voltage.

**Description:** Reads the voltmeter data. The engineering unit is Voltage (V).

**Query response:** ###.#### (floating point, 4 decimal places)

MEASure:POWer?

**Command Syntax:**

MEASure:POWer? {; | NL}

**Purpose:** Reads the power being absorbed by the load.

**Description:** Reads the power meter data. The engineering unit is Watt (W).

**Query response:** ###.#### (floating point, 4 decimal places)

MEASure:VA?

**Command Syntax:**

MEASure:VA? {; | NL}

**Purpose:** Reads the apparent power being absorbed by the load.

**Description:** Reads the apparent power meter data. The engineering unit is VoltAmperes (VA).

**Query response:** ###.#### (floating point, 4 decimal places)

## 8.6 IEEE488.2 Common Commands

The following IEEE488.2 common commands (a.k.a. star commands) are supported by the load.

### 8.6.1 *ESE

**Command Syntax:**

*ESE{?} {; | NL}

**Purpose:** Sets the Event Status Event Enable register value. Setting a bit indicates the corresponding event will trigger a service request. The bit configuration for the ESE register is shown below.

**Query Format:** Returns the Event Status Event Enable register value. Reading the register clears it.

**Query response:** {NR2}

**See also:** STATe:ERRor?, *ESR? And *STB?

ESE Register - Bit Configuration

| Position | bit 7 | bit 6 | bit 5 | bit 4 | bit 3 | Bit 2 | bit 1 | bit 0 |
|---|---|---|---|---|---|---|---|---|
| **Name** | PON | unused | CME | EXE | DDE | QYE | unused | OPC |
| **Value** | 128 | - | 32 | 16 | 8 | 4 | 2 | 1 |

Bit Definitions:

| BIT ID | BIT VALUE | REMARK |
|---|---|---|
| **bit 0** | 0 = disabled, 1 = enabled | Operation Complete |
| **bit 1** | n/a | Not used |
| **bit 2** | 0 = disabled, 1 = enabled | Query Error |
| **bit 3** | 0 = disabled, 1 = enabled | Device Dependent Error |
| **bit 4** | 0 = disabled, 1 = enabled | Execution Error |
| **bit 5** | 0 = disabled, 1 = enabled | Command Error |
| **bit 6** | n/a | Not used |
| **bit 7** | 0 = disabled, 1 = enabled | Power On |

*Table 8-11: Event Status Enable Register*

### 8.6.2 *ESR?

**Command Syntax:**

*ESR? {; | NL}

**Purpose:** Returns the Event Status Event register. Reading the register clears it. The bit configuration for the ESR register is identical to that of the ESE register. Refer to the tables shown under the *ESE? Command description above.

**Query Format:** Only the query format of this command exists. Reading the register clears it.

**Query response:** {NR2}

**See also:** STATe:ERRor?, *ESE And *STB?

### 8.6.3 *IDN?

**Command Syntax:**

*IDN? {; | NL}

**Purpose:** Returns the load Identity string.

**Description:** This command is similar to the MODEL command but returns the response in a SCPI format. The response contains four fields separated by a comma.

**Query response:** Manufacturer, model number, mainframe firmware revision, load controller firmware revision.

**Example:** APS,3B018-18,1.0,1.00

### 8.6.4 *OPC

**Command Syntax:**

*OPC {?} {; | NL}

**Purpose:** This command sets the OPC bit (bit 0) of the Standard Event Status register when the load has completed all pending operations. (See *ESE for the bit configuration of the Standard Event Status registers.)

**Description:** Pending operations are complete when all commands sent before *OPC have been executed. This includes overlapped commands. Most commands are sequential and are completed before the next command is executed. The *OPC 1 command must be part of the same message with the command for which the OPC status is requested.

**Query format:** The query causes the interface to place an ASCII "1" in the Output Queue when all pending operations are completed.

**Query response:** {NR2}

### 8.6.5 *RST

**Command Syntax:**

*RST {; | NL}

**Purpose:** The *RST command (reset) has the same effect as an IEEE-488 Device Clear bus command but can be used over the RS232C interface as well. This command resets the load to its power on default state.

### 8.6.6 *SRE

**Command Syntax:**

*SRE {?} {; | NL}

**Purpose:** This command sets the condition of the Service Request Enable Register.

**Description:** This register determines which bits from the Status Byte Register (see *STB for its bit configuration) are allowed to set the Master Status Summary (MSS) bit and the Request for Service (RQS) summary bit. A 1 in any Service Request Enable Register bit position enables the corresponding Status Byte Register bit and all such enabled bits then are logically OR-ed to cause bit 6 of the Status Byte Register to be set.

When the IEEE-488 BUS controller conducts a serial poll in response to SRQ, the RQS bit is cleared, but the MSS bit is not. When *SRE is cleared (by programming it with 0), the load cannot generate an SRQ to the controller.

**Query format:** The query format returns the Service Request Enable Register value.

**Query response:** {NR2}

### 8.6.7 *STB?

**Command Syntax:**

*STB? {; | NL}

**Purpose:** Returns the Status Byte register. Reading the Status Byte register **DOES NOT CLEAR IT**. The bit configuration for the Status Byte register is shown in the table below.

**Description:** This query reads the Status Byte register, which contains the status summary bits and the Output Queue MAV bit. Reading the Status Byte register does not clear it. The input summary bits are cleared when the appropriate event registers are read. A serial poll also returns the value of the Status Byte register, except that bit 6 returns Request for Service (RQS) instead of Master Status Summary (MSS). A serial poll clears RQS, but not MSS. When MSS is set, it indicates that the load has one or more reasons for requesting service.

**Query Format:** Only the query format of this command exists.

**Query response:** {NR2}

**See also:** STATe:ERRor?, *ESE and *ESR?

STB Register - Bit Configuration

| Position | bit 7 | bit 6 | bit 5 | bit 4 | bit 3 | Bit 2 | bit 1 | bit 0 |
|---|---|---|---|---|---|---|---|---|
| **Name** | OPER | MSS RQS | ESB | MAV | QUES | unused | unused | unused |
| **Value** | 128 | - | 32 | 16 | 8 | 4 | 2 | 1 |

Bit Definitions:

| BIT ID | REMARK |
|---|---|
| **bit 0 - 2** | Not used |
| **bit 3** | Questionable Status Summary Bit |
| **bit 4** | Message Available Bit |
| **bit 5** | Event Status Summary Bit |
| **bit 6** | Master Status Summary, Request for Service |
| **bit 7** | Operation Status Summary Bit |

*Table 8-12: Status Byte Register*

# 9 Multiple Load Operation

## 9.1 Overview

When the maximum power level of a single 3B Series electronic load is insufficient to handle an application or a multi-phase AC load is required, the user can combine two or more 3B Series loads in either parallel or multi-phase mode of operation.

## 9.2 Parallel Mode

In parallel mode, the total current is shared by the number of loads used. This type of connection will expand the power and current of the electronic load.

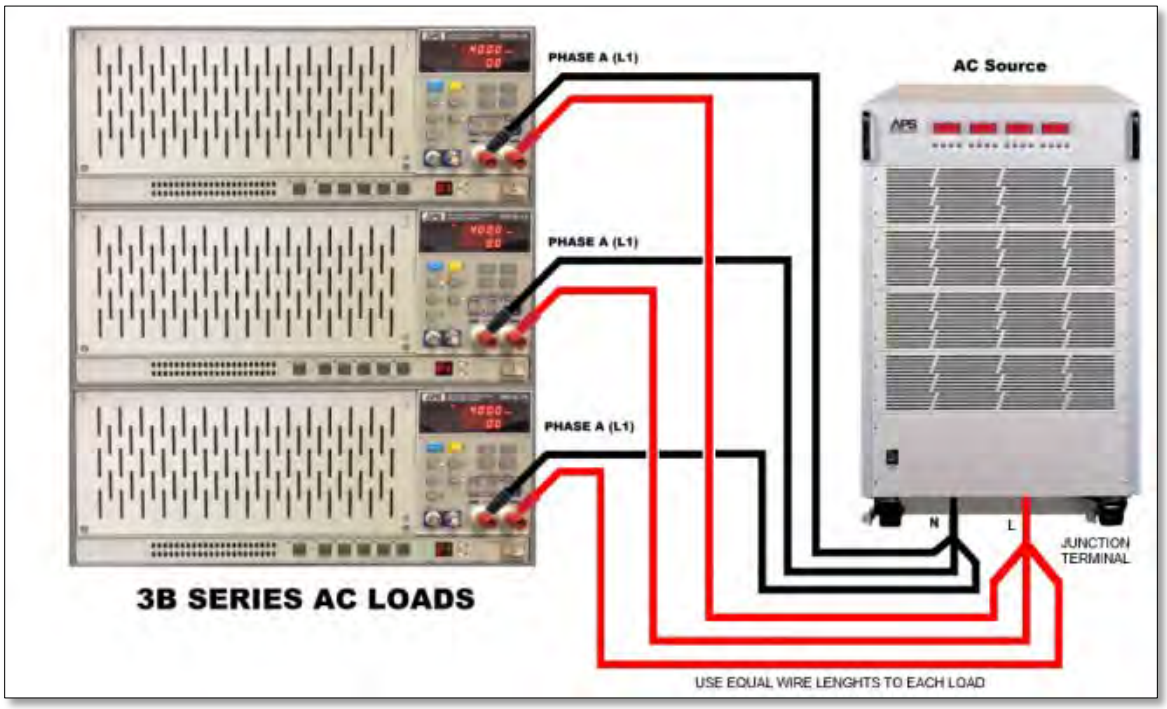



*Figure 9-1: Parallel Load Connection*

## 9.3 Multi-Phase Mode

Multi-phase AC test applications are quite common for avionics and shipboard AC power supplies or for higher power commercial applications. This requires one AC load per phase.

**Note:** External Sync mode is not recommended for multi-phase applications unless individual sync signals can be provided for each phase voltage. Do not use a single external sync signal to drive all loads in a multi-phase application.

There are two possible configurations for 3 phase loads:

**Wye Connection:** Also known as star connection or four wire plus ground. This requires a Common or Neutral connection on the AC power source.

**Delta Connection:** AC loads are connected between line-to-line voltages.

**Note:** Delta connections typically operate at higher voltages than Wye connections as they put the Line-to-Line voltage across the AC load input. Pay attention to the maximum voltage rating of the AC load when using them in this application.

**Note:** Each phase must be programmed separately as there is no 'three-phase' control mode that will program all loads to the same setting. Alternatively, the remote interface can be used to do so under program control.

Wiring diagrams for both configurations are shown in the illustrations below.

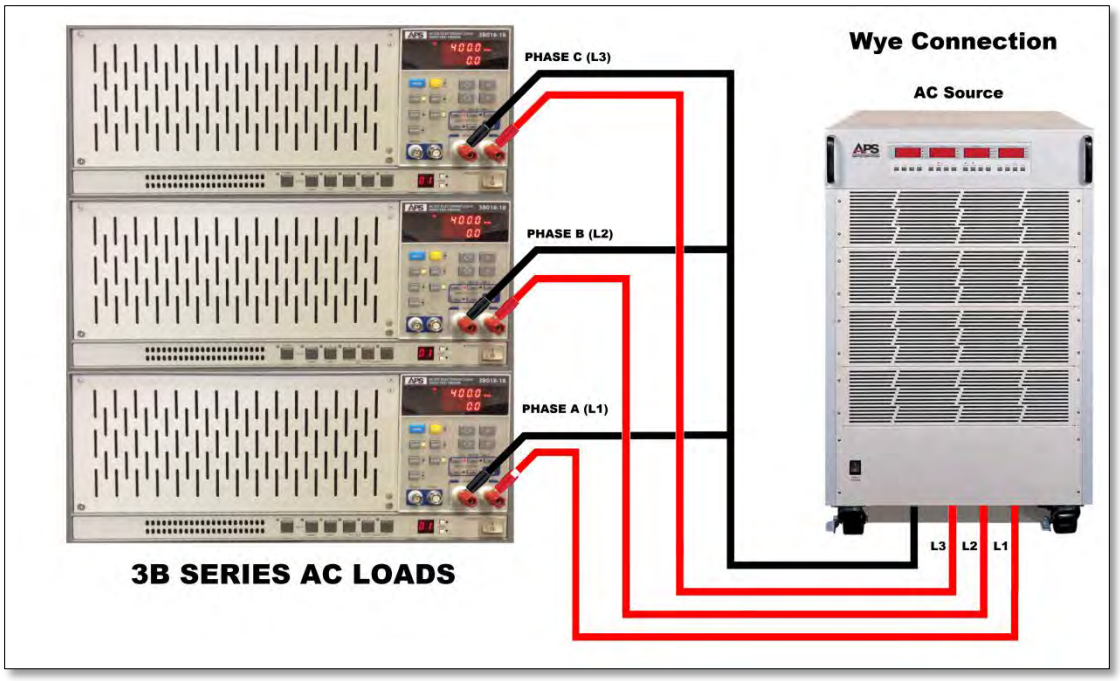



*Figure 9-2: Three Phase Wye Connection*

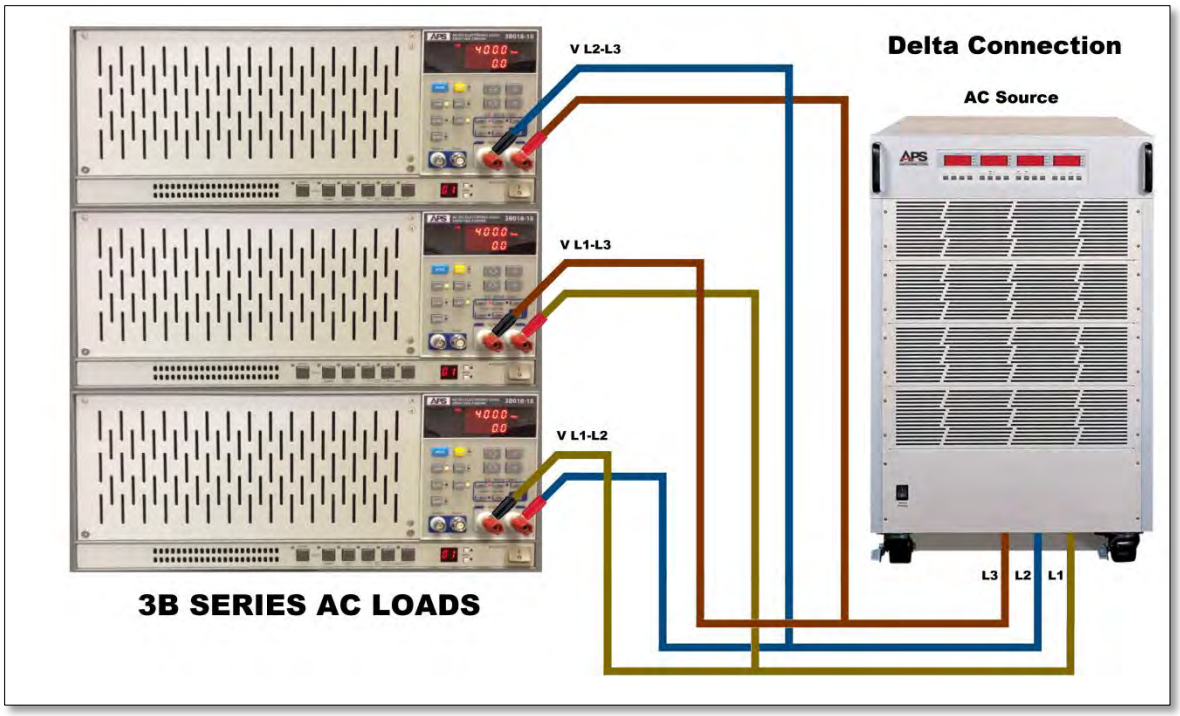



*Figure 9-3: Three Phase Delta Connection*

# 10 Calibration

## 10.1 Overview

All APS products ship with factory calibration. No additional calibration is required when first received.

## 10.2 Calibration Interval

The recommended calibration interval for these loads is one year (12 months). Routine annual calibration can be performed by most calibration labs that have Low Frequency measurement and power calibration capabilities. Alternative, the load can be returned to the manufacturer to obtain a factory calibration.

## 10.3 Calibration Coefficients

All calibration is performed through software. No manual internal adjustments have to be made as part of routine calibration.

Calibration coefficients for the following parameters and functions are stored in non-volatile memory:

| Parameters | Coefficients Stored |
|---|---|
| **Load Current** | All modes, AC & DC, Offset and Gain, High Range & Low Range |
| **Resistance** | All modes, AC & DC, Offset and Gain, High Range & Low Range |
| **Voltage Measurement** | AC&DC, Offset and Gain |
| **Current Measurement** | AC&DC, Offset and Gain |
| **Power Measurement** | AC&DC, Offset and Gain |

## 10.4 Calibration Procedures

Certified calibration labs may request a copy of the calibration manual for the relevant load model by contacting the nearest Adaptive Power Systems company location. Refer to Section 1, “Contact Information”.

# 11 CE MARK Declaration of Conformity

**Directive:** **2004/108/EC**

**Product Name** 3B Series AC & DC Electronic Loads

**Serial Number** _____

**The manufacturer hereby declares that the products are in conformity with the following standards or other normative documents:**

**SAFETY**:

**Standard applied** IEC 61010-1:2001

**EMC:**

**Standard applied** EN 61326-1:2006

**Reference Basic Standards:**

**EMISSIONS**:

CISPR11: 2003+A1: 2004+A2: 2006
EN 61000-3-2: 2006
EN 61000-3-3: 2008

**IMMUNITY**:

IEC 61000-4-2: 2008
IEC 61000-4-3: 2008
IEC 61000-4-4: 2004 +Corr.1: 2006 +Corr.2: 2007
IEC 61000-4-5: 2005
IEC 61000-4-6: 2003+A1: 2004+A2: 2006
IEC 61000-4-8: 2001
IEC 61000-4-11: 2004

**Supplemental Information:**

**When and Where Issued:** March 28, 2014
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**Authorized Signatory** Loc Tran
Quality Assurance Inspector
Adaptive Power Systems

**Responsible Person** Joe Abranko
Adaptive Power Systems
17711 Fitch
Irvine, California, 92649, USA

CE **Mark of Compliance**

# 12 RoHS Material Content Declaration

The table below shows where these substances may be found in the supply chain of APS's products, as of the date of sale of the relevant product. Note that some of the component types listed above may or may not be a part of the enclosed product.

| Part Name | Hazardous Substance | | | | | |
|---|---|---|---|---|---|---|
| | *Pb* | *Hg* | *Cd* | *Cr6+* | *PBB* | *PBDE* |
| **PCB Assy's** | x | 0 | x | 0 | 0 | 0 |
| **Electrical Parts not on PCB Assy's** | x | 0 | x | 0 | 0 | 0 |
| **Metal Parts** | 0 | 0 | 0 | x | 0 | 0 |
| **Plastic Parts** | 0 | 0 | 0 | 0 | x | x |
| **Wiring** | x | 0 | 0 | 0 | 0 | 0 |
| **Packaging** | x | 0 | 0 | 0 | 0 | 0 |

**Legend:**

0: Indicates that the concentration of the hazardous substance in all homogeneous materials in the parts is below the relevant RoHS threshold.

x: Indicates that the concentration of the hazardous substance of at least one of all homogeneous materials in the parts is above the relevant RoHS threshold.

**Notes:**

1. APS has not fully transitioned to lead-free solder assembly at this point in time. However, the vast majority of components used in production are RoHS compliant.
2. These APS products are labeled with an environmental-friendly usage period in years. The marked period is assumed under the operating environment specified in the product specifications.

Example of marking for a 10 year period.

# Index



**ADAPTIVE** Power Systems

Worldwide Supplier of Power Equipment